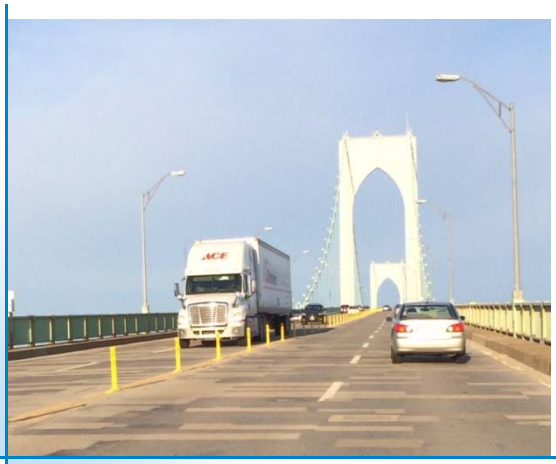

Claiborne Pell Bridge Traffic and Safety Study

Rhode Island Turnpike and Bridge Authority

March 20, 2014

CDM Smith

Executive Summary

The installation of a median barrier along the Pell Bridge to prevent crossover collisions has been discussed amongst Rhode Islanders for almost a decade. The Rhode Island Turnpike and Bridge Authority (RITBA), responsible for maintenance and operation of the Pell Bridge, began the evaluation of overall safety by initiating a study in 2005 to evaluate the structural aspects of installing a centerline median barrier. The Newport/Pell Bridge Median Barrier Conceptual Design Report[i] (PB Report) was completed by Parsons Brinkerhoff in December 2013. The report evaluated the structural aspects of installing a centerline median barrier on the Pell Bridge[1], and provided preliminary recommendations for the types of barriers that may be considered. The report did not, however, provide a traffic and safety evaluation of the overall conditions along the Pell Bridge and recommended that such a study be performed to further evaluate the installation of a median barrier.

In February 2014, the Rhode Island Department of Transportation (RIDOT) initiated a Road Safety Assessment[ii] (RSA) of the Pell Bridge. The purpose of the RSA was to provide general observations of existing conditions, and make recommendations for consideration to enhance toll plaza and interchange operations.

Following the completion of the PB Report, yet prior to RIDOT's initiation of the RSA, the RITBA requested CDM Smith Inc. prepare a formal Traffic and Safety Evaluation Study (Study), focused not only on the effects of a median barrier on traffic operations, but on a comprehensive evaluation of driver behavior and physical elements that present challenges to safety. This Study provides a continuation of the PB Report evaluation of a median barrier, while also offering a number of opportunities to improve safety, specifically along the bridge span, complemented by the results of the RSA.

This Study is divided into the following sections:

Section 1 Introduction provides a summary of existing conditions on the Pell Bridge and the contents of this Study. Understanding the existing conditions of the Pell Bridge is critical to an evaluation of a median barrier installation. Described in further detail throughout this Study, driver behavior components on the Pell Bridge that pose a challenge to improving traffic and safety conditions include distracted driving, speeding and wrong-way driving. Physical components on the Pell Bridge that pose a challenge to improving traffic and safety conditions include: a relatively narrow bridge deck (overall roadway width) accommodating four travel lanes with no physical separation between opposing traffic flows; a steep incline and decline along the length of the bridge span; horizontal curves on either bridge embankment; and a history of traffic backup from the interchange leading off the bridge.

Section 2 Collision Analysis provides an analysis of historic collision data, including information on collisions within the Pell Bridge and its toll plaza, and considerations of a potential barrier installation on the rate and severity of collisions. The Pell Bridge does not have a relatively high amount of collisions compared to similar facilities, but the crossover collisions and collisions related to distracted driving and speeding that occur do result in higher injury and fatality rates. Crossover

[1] The structural evaluation performed by Parsons Brinkerhoff considered installation of a median barrier within 5-6 feet of the centerline of the bridge.

collisions occur most often near the eastern embankment in the eastbound lanes, which may be due to high vehicle speeds in this area. Installation of a median barrier will eliminate head-on collisions, but it is likely that there will be a limited increase in property damage and potential injury collisions. Additionally, stopping sight distance will become limited at the horizontal curve near the Newport embankment, where a high rate of rear end collisions already occurs due to traffic backup from the interchange.

Section 3 Bridge Operations and Driver Behavior provides a breakdown of current standard operating procedures for the Pell Bridge, and a comprehensive summary of the established operational and regulative philosophies related to speeding, distracted driving and wrong-way drivers and the implications of such associated with a barrier installation. Median barrier installation will likely have negative impacts on emergency response, maintenance and construction operations. Further, if a median barrier is installed, it must be accompanied by reduced vehicle speeds, and concentrated efforts to minimize distracted and wrong-way driving or else the safety improvements associated with a barrier installation may be obviated by an increase in collisions with the actual barrier.

Section 4 Near-Term Alternatives provides near-term (interim) improvement options to enhance motorist compliance with the existing double yellow centerline of the Pell Bridge. The centerline pylons installed in February 2014 appear to be improving driver awareness of the centerline; however, more data is needed before a full assessment of their impact can be completed. Additionally, it is not known what the long-term effects of the pylons will be as drivers become accustomed to them.

Additional physical near-term improvements such as centerline rumblestrips, profiled thermoplastic pavement markings, and snow-plowable raised pavement markers were evaluated but are not recommended for the Pell Bridge. However, the signage improvements outlined in the RSA compliment the conclusions drawn in this Study and should be implemented to further increase traffic and safety operations on the Pell Bridge.

Section 5 Median Barrier Options provides an updated evaluation of a median barrier and barrier technologies since the research performed in the PB report. While near-term mitigation measures appear helpful to improve centerline awareness along the Pell Bridge, evaluation of the installation of a median barrier requires analysis of the actual geometry as illustrated in Section 6 – Geometric Conditions.

Bridges that have or will install a median barrier were reviewed, and all indicated positive reviews for their barriers. These bridges were comparable to the Pell Bridge, but slight differences were identified in each that could affect the impact of a median barrier on the Pell Bridge. It should be noted that similarities between the Pell Bridge and the case studies do not give carte blanche approval for installation of a median barrier on the Pell Bridge. The three reviewed barrier technologies are the Concrete Reactive Tension System – Quickchange Moveable Barrier® (CRTS), BarrierGuard 800® and concrete rigid barrier.

Section 6 Geometric Conditions provides a thorough explanation of the geometric constraints of the Pell Bridge and the alternatives and considerations for a median barrier installation. Similar to the structural analysis undertaking illustrated in the PB Report, understanding the implications that a median barrier installation may have on the Pell Bridge requires an exhaustive geometric analysis of the existing conditions. For the purposes of this Study, this section provides a geometric analysis of the Pell Bridge including a comparison with past and present design standards, cross-section features, design speed and sight distance as it relates to horizontal and vertical alignment, and an explanation of how

functional classification plays a role in determining design standards associated with a median barrier installation.

Based on a review of the geometric conditions it is feasible to install either a permanent or moveable median barrier on the Pell Bridge, provided certain conditions are met. The existing design speed of the bridge was likely 50mph when first designed. The curve on the eastbound embankment presents challenges with respect to available stopping sight distance for westbound drivers. The existing stopping sight distance for eastbound drivers is also less than standard, and could be further compromised by a median barrier, depending upon the lane configuration used.

The installation of a median barrier cannot be accommodated within the existing bridge deck width without narrowing the travel lanes. Some of the configurations developed for this study are 10.5 feet, a condition which is not desirable yet may be justified through the design exception process, ONLY IF operating speeds are significantly reduced. The remaining developed lane configurations are 11' feet or greater and would not require a design exception. It is preferable to use a reduced number of travel lanes on the Pell Bridge to provide appropriate lane widths and shoulders, but this scenario requires capacity evaluation as outlined in Section 7.

Section 7 Traffic Analysis provides a summary of the existing capacity of the Pell Bridge and the anticipated capacity if a median barrier is installed with alternative lane provisions. A traffic and safety evaluation of any facility requires the collection of traffic data, such as hourly and daily traffic volumes, directional distribution, vehicle type classification, and vehicle speeds. Traffic data is used for a variety of analyses, but is primarily used to determine the capacity (the amount of traffic a facility can process) of a facility.

The capacity analysis (performed using two different methodologies) indicates that the provision of one travel lane in each direction will not provide adequate capacity for existing (2013) traffic volumes on the bridge. Further, while a three-lane section (alternating to allow for directional increases in traffic flow during peak periods) would provide adequate capacity, improvements at the interchange will need to occur to facilitate eastbound traffic flow.

Section 8 Recommendations reiterates the conclusions drawn from the various analyses and research performed. In summary, this Study has documented the existing conditions along the Pell Bridge, what opportunities exist to make safety improvements associated with bridge operations and driver behavior, and identifies two different barrier alternatives for RITBA to select, dependent on acceptance that vehicle speeds must be lowered, distracted driving is curbed, wrong-way driving is addressed, and design exceptions can be justified and obtained.

The following recommendations have been drawn based on the evaluation of traffic and safety conditions on the Pell Bridge as well as the median barrier implications and conclusions developed in each Section of this Study. These recommendations have been broken down into near-term, long-term and median barrier improvements.

Near-Term Improvements

The following near-term improvements are recommended based on the conclusions drawn in this Study:

- Consider installing mile markers every tenth of a mile on the bridge to provide a reference for accurate collisions reporting. Possible locations for the mile markers are the railings, or painted on the safety walkway or light poles.
- Consider increasing enforcement efforts to deter distracted driving and speeding. Enforcement should be increased during the hours illustrated in Section 2 to have trending periods of collisions.
- Consider trimming back the vegetation on the north side of the east horizontal curve to increase sight distance for westbound drivers.
- Consider implementing speed documentation using cameras without fines to notify drivers of their actual speeds while traveling the Pell Bridge.

Long-Term Improvements

The following long-term improvements are recommended based on the conclusions drawn in this Study:

- Consider implementing the signage improvements and modifications to the Newport interchange, along with the additional recommended improvements in the RSA conducted by RIDOT.
- Consider continuing to study the pylons installation over the next six months. Evaluation during this time period should include observations on the number of times the pylons are struck by vehicles; if there appears to be a decrease in the number of crossover, sideswipe, and U-turn collisions along the span of the bridge; if the pylon impacts by vehicles decrease over time; calculations of an estimated shy distance between the pylons and vehicles of various sizes; and observations of the general speed of vehicles.
- Consider continuing to provide support and interest in increasing penalties for distracted driving offenses, as well as continuing to investigate the possibility of automated speed enforcement as a pilot program for the Pell Bridge. The Pell Bridge meets the criteria for automated speed enforcement as a roadway that has experienced severe, high-profile collisions and has geometric considerations that hinder traditional enforcement. To install a system, legislation will be required to allow automated speed enforcement fining statewide, or specifically on the Pell Bridge. If legislation is approved to allow automated speed enforcement on the Pell Bridge, it is recommended that the following steps be considered:
  - Pursue a 2-year trial period, which may have more success in being implemented than an overall state program. Funds generated from the program could be used for activities such as camera maintenance.
  - Develop guidelines outlining the programs use, components and restrictions in concert with RIDOT standards.
  - Address any deficiencies associated with appropriate signage that warns vehicles of the approaching speed limit and enforcement before the system is implemented.
  - Present an education campaign that clearly states the need and use of the systems for the benefit of the public, with educational material made available.

- Coordinate with law enforcement, as an automated enforcement program should not replace a traditional enforcement system.
- Anticipate that maintenance costs may arise, depending upon the revenue received from citations as well as the use of such revenue.
- Monitor the program to track the performance and operation of the system.

▪ Consider implementation of automatic wrong-way driver deterrence systems similar to recent RIDOT undertakings.

Median Barrier Installation

Although a median barrier installation would be the most effective means to reduce and eliminate crossover collisions, such an installation must be accompanied by reduced vehicle speeds, and concentrated efforts to minimize distracted and wrong-way driving or else the safety improvements associated with a barrier installation may be obviated by an increase in collisions with the actual barrier. While preliminary analysis has been completed, it is recommended that manual traffic data collection be performed during the summer months to confirm the vehicle classification and transaction types per lane at the toll plaza. In addition, future traffic volume growth and ramp interchange improvements on the eastern end of the bridge need further consideration.

Roadway lane configurations for consideration by the RITBA have been categorized into two types; permanent barrier installation and a moveable barrier installation. The preferred permanent barrier scenario and preferred moveable barrier scenario are detailed below:

Permanent Barrier Scenario #1:

This permanent barrier scenario would maintain two travel lanes in each direction. A design exception will be required due to travel lanes less than 11 feet in width, existing stopping sight distance limitations will be exacerbated along the horizontal curve, and the bridge would most likely be designated functionally obsolete by the FHWA under this alternative. Vehicle speed and distracted/wrong-way driving reductions are critical under this alternative to minimize collisions with the actual barrier.

Moveable Barrier Scenario #1:

This moveable barrier scenario would provide three 11.5-foot travel lanes. This scenario was chosen as the preferred moveable barrier lane configuration since this alternative allows for 11.5 foot travel lanes accompanied by a striped shoulder. Since the current roadway lane configuration on the Pell Bridge provides 11.5-foot travel lanes, this moveable barrier scenario would not result in further reduction of lane widths but will result in one less travel lane on the bridge. In addition, an offset of 4 feet on either side of the median barrier can be provided in the one-lane direction. This alternative will provide a median barrier installation that does not require a design exception for lane widths, provides actual shoulders (4-foot) and provides an offset to the median barrier. A design exception will still be required due to the limited stopping sight distance available.

Table E.1 summarizes the advantages and disadvantages of the different barrier technologies. For permanent barrier scenario #1, the BarrierGuard 800 system is recommended. For moveable barrier scenario #1, the CRTS is recommended. The concrete rigid barrier is not recommended for any barrier installations of the Pell Bridge.

Table E.1 – Advantages and Disadvantages of Barrier Technologies

Median Barrier	Advantages	Disadvantages
CRTS	▪ A primarily unanchored system that will not significantly impact the bridge deck. ▪ Moveable feature allows for lanes to be easily reconfigured for traffic to accommodate peak traffic flows or during construction. ▪ Used on large bridges across the world	▪ High deflection distance (lowest deflection distance for an unanchored system though) ▪ Heavy ▪ High cost ▪ Requires regular maintenance ▪ Limited operations for emergency procedures
BarrierGuard 800	▪ Minor deflection distance ▪ Light weight ▪ Gate option for emergency procedures	▪ Requires bridge deck to be anchored every 20-feet ▪ Not commonly used as a permanent barrier system
Concrete Rigid	▪ Zero deflection ▪ Requires little to no maintenance ▪ Most familiarized barrier system	▪ Continuously anchored into bridge deck ▪ Greatest impact on vehicle and vehicle occupants upon collision ▪ Heavy

In summary, this Study has documented the existing conditions along the Pell Bridge, what opportunities exist to make safety improvements associated with bridge operations and driver behavior, and identifies two different barrier alternatives for RITBA to select, dependent on acceptance that vehicle speeds must be lowered, distracted driving is curbed, wrong-way driving is addressed, and design exceptions can be justified and obtained.

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[i] *Median Barrier at the Newport/Pell Bridge Conceptual Design Report*, Parsons Brinkerhoff, December 2013.

[ii] *Route 138/Pell Bridge Road Safety Assessment*, Vanasse Hangen Brustlin, Inc. February 2014.