Chloe's Law

Review and Analysis of Crashes

Office of Design

Florida Department of Transportation

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Chloe's Law - Review and Analysis of Crashes

For

Office of Design
Florida Department of Transportation

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Executive Summary

This report is in response to "Chloe's Law" enacted by the Florida Legislature in 2016 and found in Chapter 2016-239, Sections 37 and 38, Laws of Florida, quoted as follows:

Section 37. Section 335.085, Florida Statutes, is created to read:

335.085 Installation of roadside barriers along certain water bodies contiguous with state roads.—
(1) This section shall be cited as "Chloe's Law."
(2) By June 30, 2018, the department shall install roadside barriers to shield water bodies contiguous with state roads at locations where a death due to drowning resulted from a motor vehicle accident in which a vehicle departed the adjacent state road during the period between July 1, 2006, and July 1, 2016. This requirement does not apply to any location at which the department's chief engineer determines, based on engineering principles, that installation of a barrier would increase the risk of injury to motorists traveling on the adjacent state road.

Section 38. The Department of Transportation shall review all motor vehicle accidents that resulted in death due to drowning in a water body contiguous with a state road and that occurred during the period between July 1, 2006, and July 1, 2016. The department shall use the reconciled crash data received from the Department of Highway Safety and Motor Vehicles and shall submit a report to the President of the Senate and the Speaker of the House of Representatives by January 3, 2017, providing recommendations regarding any necessary changes to state laws and department rules to enhance traffic safety.

To address the requirements of Chloe's Law, a review of police crash reports of all fatal crashes coded as "ran off road into water" on the State Highway System occurring between July 1, 2006 and July 1, 2016 was conducted. The FDOT Design Office working with the FDOT Safety Office identified 89 crashes which occurred during this period that were determined to be potentially relevant to Chloe's Law requiring further examination. Not all were determined to be relevant as it was determined that 2 crashes did not involve a water body, 7 crashes were located on local jurisdiction roads (including Chloe's crash) and 10 crashes did not involve death by drowning. There were 45 crashes that clearly involved death by drowning. A clear cause of death could not be obtained or determined for 25 crashes. For purposes of compliance with Chloe's Law, the 25 "undetermined" crashes were treated the same as the 45 crashes where the cause of death was by drowning. This resulted in a total of 70 drowning crashes (averaging 7 crashes per year) subject to Chloe's Law requirements.

With the assistance of the District offices, it was determined of the 70 drowning crashes, barriers were in place at the time of crash at 28 locations, and barriers were installed subsequent to the time of crash at 13 locations. Thus, at the time this report was prepared barriers exist at 41 of the 70 drowning crash locations. Of the 29 crash locations without existing barriers, either a barrier will be installed or the water hazard will be removed at 24 locations by June 30, 2018 as required by Chloe's Law. There are 5 drowning crash locations where barriers are not recommended based on engineering principles. Appendix A provides additional details and the engineering principles used on the 5 locations where barriers are not recommended. Appendix B provides a tabulation of all 70 drowning crashes and the status of barriers at each crash location.

Additional analysis was conducted on the 70 drowning crashes to identify trends and get a better understanding of their characteristics. Crashes were grouped by Roadway Type and were found to generally fall into 6 different crash types or scenarios described as follows:

Crash Types

1. Parallel Water Bodies – run off road
2. Cross Drain Culverts – run off road
3. Bridges over Water – penetrate or overtop bridge railing
4. Bridge Approaches to bridges over water – vehicle misses or crosses approach barrier
5. Side Road Bridges near Intersections – penetrating or overtopping barriers perpendicular to direction of travel
6. T-Intersections – vehicle crosses intersection into the water body on opposite side of intersection.

It was found that the majority of drowning crashes occurred in water bodies parallel to roadways (77.1%) and the majority of these type crashes occurred on Limited Access and Rural Multilane roadways (81.5%). Crashes for the other scenarios each account for a relatively small percentage (4.3% to 5.7%). There were 4 crashes (2 with no barrier and 2 with barriers) that occurred involving waterbodies perpendicular to the direction of travel at T-intersections, similar to the crash scenario on which Chloe's Law is based.

Another finding, as indicated above, is that the presence of barriers to shield water bodies does not eliminate drowning crashes. There were 28 drowning (40%) crashes at locations where the water body was shielded. This includes crashes into parallel water bodies at offset distances up to 125 feet from the nearest travel lane.

In a previous study completed in 2013, crashes coded as "Ran Off Road into Water" were compared with other "Ran Off Road" crash types for the years 2003 through 2013. Of 14 different run off road harmful events, the highest number of fatalities was motor vehicle hit tree/shrubbery (436 fatal crashes). Ran off Road into Water fatal crashes ranked 12th (60 fatal crashes), well below fatal crashes where motor vehicle hit guardrail (rank 3rd with 313 fatal crashes) and motor vehicle hit concrete barrier wall (rank 4th with 195 fatal crashes).

There were no findings to suggest changes to FDOT design criteria on the use of barriers to shield water bodies. The crash data obtained for this study provided information that was similar to information provided in the previous study completed in 2013. The previous study confirmed FDOT's existing criteria for shielding parallel water bodies is cost effective and exceeds requirements commonly used throughout the nation. To add even more stringent requirements for installing barriers runs the risk of unnecessarily increasing the overall frequency of crashes with minimal gain in terms of reducing drowning crashes, and in certain instances the barrier may become more hazardous than the water body it is intended to protect.

Finally, the data suggests barriers would not be effective to stop a vehicle for the sole purpose of shielding water bodies located perpendicular to the direction of travel. . For this type of crash other mitigation techniques may need to be considered, such as improved delineation, signing, object markers, lighting, addition of rumble strips approaching the intersection, etc. Ideally, the best solution would be to relocate or realign the intersection or relocate the water body so that such a condition does not exist. This would likely be cost prohibitive for most existing locations, but should be a consideration on new and reconstruction projects.

Chloe's Law - Review and Analysis of Crashes

1. Identification of Drowning Crashes

This report is in response to "Chloe's Law" enacted by the Florida Legislature in 2016 and addressed in Chapter 2016-239, Sections 37 and 38, Laws of Florida, quoted as follows:

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(2) By June 30, 2018, the department shall install roadside barriers to shield water bodies contiguous with state roads at locations where a death due to drowning resulted from a motor vehicle accident in which a vehicle departed the adjacent state road during the period between July 1, 2006, and July 1, 2016. This requirement does not apply to any location at which the department's chief engineer determines, based on engineering principles, that installation of a barrier would increase the risk of injury to motorists traveling on the adjacent state road.

Section 38. The Department of Transportation shall review all motor vehicle accidents that resulted in death due to drowning in a water body contiguous with a state road and that occurred during the period between July 1, 2006, and July 1, 2016. The department shall use the reconciled crash data received from the Department of Highway Safety and Motor Vehicles and shall submit a report to the President of the Senate and the Speaker of the House of Representatives by January 3, 2017, providing recommendations regarding any necessary changes to state laws and department rules to enhance traffic safety.

To address the requirements of Chloe's Law, a review of police crash reports of all fatal crashes coded as "ran off road into water" on the State Highway System occurring between July 1, 2006 and July 1, 2016 was conducted. The FDOT Design Office working with the FDOT Safety Office identified 89 crashes which occurred during this period that were determined to be potentially relevant to Chloe's Law requiring further examination. Not all were determined to be relevant as explained in this report. Police crash reports were collected and a spreadsheet was prepared by the FDOT Design Office with input by the District Offices to provide the following information:

- Location where crash occurred
- Police crash report number
- Year of crash

- Whether drowning was cause of death
- Whether a barrier is present at the crash location

Efforts to complete the information in the spreadsheet resulted in the following crashes that were determined not to be relevant to Chloe's Law and were excluded from further review:

- There were 2 crashes in the furnished data that did not involve any discernable body of water and were apparently miscoded.
- It was determined that 7 crashes occurred on local jurisdiction roads, i.e., roads that are not on the State Highway System and not under the jurisdiction of FDOT.
- There were 10 crashes where the cause of death was not by drowning.

The 7 crashes on local jurisdiction roads do not account for all of the lane departures resulting in a death due to drowning on local jurisdiction roads. These are crashes that occurred on a local jurisdiction road at or near an intersection with a state road, or were crashes that were inadvertently coded into the state highway system crash database. One of these crashes is the fatal crash on which Chloe's Law was based. Chloe's crash occurred in a stormwater pond on Alafaya Trail opposite of where eastbound State Road 408 exit ramp 21 intersects Alafaya Trail. Alafaya Trail is a local jurisdiction road in Orange County. As explained later in this report, installation of roadside barriers should not be used to address crash types similar to Chloe's crash. FDOT notified Orange County for consideration of changes the county may want to pursue. The final disposition for any changes at this crash location was not available when this report was produced.

As stated above, it was determined that for 10 crashes drowning was not the cause of death. Specific cause of death is not always identified in crash reports, nor is it a detail recorded in FDOT's crash database. There are many cases where cause of death is the result of blunt force trauma occurring from crash events such as rollover, ejection, collision with other vehicles or collision with fixed objects including roadside barriers, etc. – all of which may happen prior to entering water or after passing through water. In a few cases cause of death was the result of a driver's medical condition. A concerted effort was made by FDOT to identify the cause of death for all relevant crashes, excluding the 7 local jurisdiction roads and the 2 crashes with no water. Of the remaining 70 crashes, it was determined that 45 crashes involved death by drowning and a clear cause of death could not be obtained or determined for 25 crashes. For purposes of compliance with Chloe's Law, the 25 "undetermined" crashes were treated the same as the 45 crashes where the cause of death was by drowning.

The 70 crashes were reviewed by the Districts to determine the following:

- Locations where barriers were in place at the time of crash
- Locations where barriers were not in place at the time of crash but had since been added after the crash
- Locations with no existing barrier

- A Recommendation on whether to install barriers at crash locations where barriers do not exist, in accordance with Chloe's Law.

This information is summarized in Table 1.

Table 1
Status of Barriers at Crash Locations

Description	Cause of Death		Total
	Drowning	Undetermined	
No. of Locations with Barriers at time of crash	18	10	28
No. of Locations Barriers were installed subsequent to time of crash	5	8	13
Subtotal – Crash Locations with Existing Barriers	23	18	41
No. of Locations with Barriers to be installed or other change made to relocate or eliminate water hazard by June 30, 2018	20	4	24
No. of Locations where Barriers are not proposed based on engineering principles	2	3	5
Subtotal – Crash Locations without Existing Barriers	22	7	29
Total of Crash Locations	**45**	**25**	**70**

For simplicity, all 70 crashes will be referred to as drowning crashes throughout the remainder of this report.

As indicated in Table 1, of the 70 drowning crashes, barriers were in place at the time of crash at 28 locations, and barriers were installed subsequent to time of crash at 13 locations. Thus, barriers exist at 41 of the 70 drowning crash locations at the time of this reports preparation. Of the 29 crashes without existing barriers, either a barrier will be installed or the water hazard will be removed at 24 locations by June 30, 2018 as required by Chloe's Law. There are 5 locations where barriers are not recommended based on engineering principles.

Appendix A provides additional details and the engineering principles used on the 5 locations where barriers are not recommended. Appendix B provides a tabulation of all crashes and the status of barriers at each crash location.

2. Characteristics of Drowning Crashes

While plans are proceeding to install barriers or make changes at all but 5 crash locations, additional analysis was conducted on the 70 drowning crashes to identify trends and get a better understanding of their characteristics. Crash location maps (google maps) with measurements for offsets to water body, length of water body, width of water body, and offsets to barriers if present, prepared from a previous study of 2007 – 2011 crashes completed in 2013 were used. This was supplemented with similar maps and measurements prepared by the FDOT State Roadway Design Office for crashes not mapped in the previous study. This information along with information from crash reports is summarized as follows:

2.1 Roadway and Crash Types

As would be expected, review of the crash reports of the 70 drowning crashes show significant differences in characteristics of the crash conditions and roadway configuration at each location. Basically, the crashes can be grouped into 7 different roadway types and 6 different crash types or scenarios described as follows:

Roadway Types

1. Limited Access (Interstate and Freeways)
2. Ramps
3. Rural 2-Lane
4. Rural Multilane
5. Urban 2-Lane
6. Urban Multilane
7. Access Road

Crash Types

1. Parallel Water Bodies – run off road
2. Cross Drain Culverts – run off road
3. Bridges over Water – penetrate or overtop bridge railing
4. Bridge Approaches to bridges over water – vehicle misses or crosses approach barrier
5. Side Road Bridges near Intersections – penetrating or overtopping barriers perpendicular to direction of travel
6. T-Intersections – vehicle crosses intersection and continues beyond road resulting in head on impact into the water body on opposite side of intersection.

FDOT's design criteria and long standing practice for using barriers differ for each of these scenarios. These scenarios and associated FDOT criteria are each described in more detail in the following sections of this report.

Table 2 provides a summary of drownings by crash type, type of road and whether barriers were in place at the time of crash for the period July 1, 2006 through June 30, 2016. As noted in the table, the majority of drowning crashes occurred in parallel water bodies (54 of 70 = 77.1%) and the majority of these type crashes occurred on Limited Access and Rural Multilane roadways (44 of 54 = 81.5%). Crashes for the other scenarios each account for a relatively small percentage. Additionally, there were 4 crashes (2 not shielded and 2 shielded) that occurred involving waterbodies perpendicular to the direction of travel.

Table 2
Number of Drowning Crashes
by Crash Type, Type Road and Presence of Barrier at Time of Crash

Type Road	Parallel		Cross Drain		Bridge	Bridge Approach	Side Road Bridge	T-Intersection		Total
	Barrier		Barrier		Barrier	Barrier	Barrier	Barrier		
	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	
Limited Access	15	8			2	1				26
Ramp	4		1					1	1	7
Rural 2-Lane	3	1								4
Rural Multilane	10	5	1			1	1			18
Urban 2-Lane	1				1					2
Urban Multilane	4	1	1			1	2	1	1	11
Access Road		2								2
Total	**37**	**17**	**3**		**3**	**3**	**3**	**2**	**2**	**70**
Percent of Total	**52.9**	**24.3**	**4.3**		**4.3**	**4.3**	**4.3**	**2.9**	**2.9**	**100.0**

2.2 Barrier Types

Table 3 tabulates and provides a summary of drowning crashes that occurred where barriers were not present compared to crashes occurring where different types of barriers were present. Of note is that barriers were in place at the time of crash at 40% (28 of 70) of the locations where these crashes occurred.

Table 3
Number of Drowning Crashes by Road Type and Barrier Type

Type Roadway	Not Shielded at Time of Crash	Shielded with Barriers at Time of Crash					Total Crashes
		Guardrail	Cable	Concrete Barrier	Concrete Post and Beam	Total Shielded at Time of Crash	
Limited Access	15	5	4	2		11	26
Ramp	6			1		1	7
Rural 2-Lane	3	1				1	4
Multilane Rural	11	7				7	18
Urban 2-Lane	1				1	1	2
Urban Multilane	6	2		3		5	11
Access Road		2				2	2
Total	**42**	**17**	**4**	**6**	**1**	**28**	**70**

2.3 Water Body Type

Table 4 summarizes the number of crashes that occurred for each crash type by type of water body involved. The majority of these crashes by far occur in canals (39 of 70 = 55.7%) followed by stormwater ponds (11 of 70 = 15.7%).

Table 4
Number of Drowning Crashes
by Road Type, Crash Type and Water Body Type

Road Type and Crash Type	Water Body Type						
	Roadside Ditch	Stormwater Pond	Canal	Lake	Tidal Bay	River	Total
Limited Access							
Parallel	2	3	17	1			23
Bridge						2	2
Bridge Approach						1	1
Ramps							
Parallel		3		1			4
Cross Drain			1				1
T-Intersection		1	1				2
Rural 2-Lane							
Parallel	1		2		1		4
Rural Multilane							
Parallel	1	1	11	1	1		15
Cross Drain			1				1
Bridge Approach						1	1
Side Road Bridge			1				1
Urban 2-Lane							
Parallel		1					1
Bridge					1		1
Urban Multilane							
Parallel		2	1	2			5
Cross Drain			1				1
Bridge Approach			1				1
Side Road Bridge			2				2
T-Intersection				2			2
Access Road							
Parallel					2		2
Grand Total	**4**	**11**	**39**	**7**	**5**	**4**	**70**

2.4 Crash Locations

Table 5 summarizes drowning crashes by county and roadway type with the number of drowning crashes by county sorted in descending order. For the period July 1, 2006 through June 30, 2016, Miami-Dade County and Palm Beach County each had 14 drowning crashes, the highest number of all counties. This was followed by Broward County with 7, Collier with 5, and Brevard and Hillsborough with 4 each. Drowning crashes occurred in 21 of Florida's 67 counties. This included 12 counties having 2 or more drowning crashes and 9 counties with 1 drowning crash each.

With regard to roadway type, the majority of these crashes occurred on Limited Access roadways (26), followed by Rural Multilane roadways (18), Urban Multilane roadways (11) and Ramps (9). Rural 2-Lane roadways and Urban 2-Lane roadways each had 2 crashes.

Table 5
Number of Drowning Crashes by County and Road Type

County	Limited Access	Ramp	Rural 2-Lane	Rural Multilane	Urban 2-Lane	Urban Multilane	Access Road	Total
Miami-Dade	3	1	2	3		5		14
Palm Beach	5			8		1		14
Broward	5	1				1		7
Collier	4					1		5
Brevard	2			1		1		4
Hillsborough	1	1					2	4
Orange	1	1		1				3
Duval	1	1						2
Pinellas		1				1		2
Sarasota	1				1			2
Seminole		1				1		2
St. Lucie	2							2
Franklin			1					1
Hendry				1				1
Lee	1							1
Manatee					1			1
Osceola				1				1
Pasco				1				1
Santa Rosa				1				1
Taylor			1					1
Volusia				1				1
Total	**26**	**7**	**4**	**18**	**2**	**11**	**2**	**70**

2.5 Roadway Alignment

Table 6 summarizes the number of crashes that occurred on straight versus curved alignments and at intersections. A total of 54 of the 64 non-intersection crashes (84.4%) occurred on straight alignments. However, in the case of ramps, there were more fatal crashes on curved alignments (5) than straight (2).

Table 6 Number of Drowning Crashes by Alignment and Road Type				
Type Roadway	**Straight**	**Curve**	**Intersection**	**Total**
Limited Access	25	1		26
Ramp	2	5		7
Rural 2-Lane	4			4
Rural Multilane	16	1	1	18
Urban 2-Lane	2			2
Urban Multilane	5	1	5	11
Access Road		2		2
Total	54	10	6	**70**

2.6 Comparing FDOT Design Criteria, Chloe's Law and Drowning Crashes

The following describes FDOT's current design criteria for installing barriers for each of the crash types and how this criteria relates to Chloe's Law and the drowning crashes that occurred between July 1, 2006 and June 30, 2016.

2.6.1 Parallel Water Bodies

As shown in Table 4 above, parallel water bodies may include roadside ditches, canals, lakes, stormwater ponds and tidal bays. Current FDOT criteria for shielding parallel water bodies differs for parallel lengths greater than or equal to 1000 feet vs. lengths less than 1000 feet as shown in Table 7.

Table 7 Summary of FDOT Design Criteria for Shielding Parallel Water Bodies Source: FDOT Plans Preparation Manual		
Length of Water Body (feet)	**Roadway Type**	**Minimum Offset Distance without Barrier (feet)**
< 1000	All	Clear Zone Width*
≥ 1000**	All with Design Speed > 45 mph	60
	Flush Shoulder Roadways with Design Speed ≤ 45 mph	50
	Curbed Roadways with Design Speed ≤ 45 mph	40
* FDOT clear zone width requirements typically vary from 18 feet to 36 feet depending on design speed. ** For application of this criteria, a water body is defined as having a depth in excess of 3 feet for a period of 24 hours or more.		

FDOT shielding requirements for parallel water bodies equal to or greater than 1000 feet substantially goes beyond the national standards established in the AASHTO Roadside Design Guide. Nationally, most states base their shielding requirements for water bodies on clear zone distances regardless of length. FDOT's stringent requirements for shielding water bodies were first established in 1965 due to the high number of fatal crashes occurring in canals in south Florida. These requirements resulted in extensive use of roadside barriers throughout south Florida where the majority of canals exists. In addition to providing barriers where minimum offset distances are insufficient, there are segments where barriers have been installed to shield water bodies offset at greater distances. This is usually done based on actual crash experience. However, a recent previous study completed in 2013 confirmed that FDOT requirements were cost effective in mitigating water crashes and did not recommend changes be made to this criteria.

Parallel Water Body Lengths and Offset Distances where Drowning Crashes Occurred: Table 8 is a summary of water body lengths and offset distances associated with drowning crashes on Limited Access, Ramps, Rural 2-Lane and Rural Multilane roadways. Both not shielded and shielded conditions are shown. The table shows that even for water bodies shielded with barriers there were crashes into water bodies at offset distances up to 125 feet. This table also shows the largest majority of crashes by far occurred in parallel water bodies greater than or equal to 1000 feet in length.

Table 8
Number of Drowning Crashes by Length of Water Body and Offset Distance
Limited Access, Ramps, Rural 2-Lane and Rural Multilane

Length of Water Body Parallel to the Roadway (Feet)	Offset Distance to Water Body from Nearest Travel Lane (Feet)																							
	15	18	20	24	25	26	30	36	40	50	55	60	65	70	75	80	90	95	100	105	110	120	125	Total
Not Shielded																								
Parallel																								
200																1								1
390												1												1
400								1																1
440												1												1
525										1														1
680					1																			1
≥ 1000	1					1	2	1			1	2	5	1	2	3	2		1	1		2	1	26
Subtotal	1				1	1	2	2		1	1	4	5	1	2	4	2		1	1		2	1	32
Cross Drain																								
30			1																					1
40		1																						1
Subtotal		1	1																					2
Shielded																								
Parallel																								
230												1												1
≥ 1000			1	1				2	1		1		1	1		1		2			1		1	13
Subtotal			1	1				2	1		1	1	1	1		1		2			1		1	14
Grand Total	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**4**	**1**	**1**	**2**	**5**	**6**	**2**	**2**	**5**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**48**

FDOT criteria is to shield parallel water bodies 1000 feet and longer for water body offsets less than 60 feet.

Table 9 is a summary of water body lengths and offset distances associated with crashes involving drownings on Urban 2-Lane and Urban Multilane roadways. Both not shielded and shielded conditions are shown. The number of crashes on urban roadways are far less than those occurring on limited access and rural roadways.

Table 9
Number of Drowning Crashes by Length of Water Body and Offset Distance Urban 2-Lane and Urban Multilane

Length of Water Body Parallel to the Roadway (Feet)	Offset Distance to Water Body from Nearest Travel Lane (Feet)									
	15	30	40	50	60	70	80	100	120	Total
Not Shielded										
Parallel										
270									1	1
320					1					1
370							1			1
750						1				1
1500								1		1
Cross Drain										
36		1								1
Subtotal		1			1	1	1	1	1	6
Shielded										
Parallel										
2500	1									1
Subtotal	1									1
Grand Total	1	1			1	1	1	1	1	7

FDOT criteria is to shield parallel water bodies 1000 feet and longer for water body offsets less than 40 feet for curbed roadways and 50 feet for flush shoulder roadways for speeds ≤ 45 mph

Offset Distance to Barriers: Table 10 summarizes the offset distances to barriers at drowning crash locations involving parallel water bodies where barriers were present. Typically roadside barriers are placed at the shoulder point. Barriers are sometimes placed well beyond the shoulder when site conditions permit. The greater the offset distance, the less likely the barrier will be impacted. FDOT criteria for shielding canal hazards call for barrier placement to be located as far from the travel way as practical and outside the clear zone when possible. The offset distances shown in the table indicate this practice has been followed at a number of locations.

Table 10 Number of Drowning Crashes by Offset Distance to Barriers Limited Access, Ramps, Rural 2-Lane, Rural Multilane, Urban 2-Lane and Urban Multilane										
Barrier Type	**Offset Distance to Barrier from nearest Travel Lane (Feet)**									**Total**
	6	**10**	**12**	**24**	**30**	**40**	**46**	**60**	**80**	
Parallel										
Guardrail	1	1	6	1		1	1			11
Cable					2			1	1	4
Total	**1**	**1**	**6**	**1**	**2**	**1**	**1**	**1**	**1**	**15**

Water Body Width: Table 11 summarizes the smallest and greatest widths of parallel water bodies where drowning crashes occurred. Widths varied considerably between the smallest and greatest widths measured.

Table 11 Number of Drowning Crashes Into Parallel Water Bodies by Water Body Type and Water Body Width Not Shielded and Shielded			
Water Body Type	**Total Crashes All Widths**	**Widths of Water Bodies involving Fatal Crashes Measured Perpendicular to Roadway - Feet**	
		Smallest Width	Greatest Width
Roadside Ditch	4	15	30
Stormwater Pond	10	100	590
Canal	34	40	155
Lake	5	140	670
Tidal Bay	2	70	1000+

Chloe's Law: With the exception of 3 locations, all drowning crash locations at parallel water bodies with no barrier at the time of crash will be retrofitted with barriers or reconstructed to eliminate or relocate the hazard. At some sites this work has been completed. Based on engineering principles, barriers are not recommended for 3 crash locations at parallel water bodies. These locations are identified and discussed in Appendix A. Two of the locations involved roadside ditches and a third location involved a canal.

2.6.2 Cross Drain Culverts

Cross drain culverts carry water flow from one side of the road to the other. Such water bodies may include lateral ditches, canals, and stream channels and extend for a relatively short distance parallel to the roadway. The offset distance from the travel lane to water for a cross drain culvert is established by the culvert endwall. Standard FDOT practice is to place endwalls for culvert cross drains at or beyond the clear zone (18 to 36 feet depending on design speed) which would also locate the water body outside the clear zone. As with water bodies less than 1000 feet parallel to the roadway, FDOT criteria requires shielding of endwalls when located within the clear zone.

Chloe's Law: There were 3 drowning crashes associated with waterbodies at culvert endwalls as indicated in Tables 2 and 4 above. A barrier has already been installed at one of the crash locations. Plans are underway to address a second location which will involve either the addition of shielding and/or extending the endwall further from the travel lanes. Analysis of the third location indicates a barrier is not warranted based on engineering principles as explained in Appendix A (Crash Number 735819460).

2.6.3 Bridges

Current FDOT criteria requires barriers (also referred to as bridge railings) on all bridges on the State Highway System including those over water bodies. Such water bodies include rivers, stream channels, canals and tidal bays.

Chloe's Law: There were 3 drowning crashes involving bridges as indicated in Tables 2 and 4. In all 3 crashes the vehicle rolled over or vaulted over the top of the bridge railing. At one location, the railing is an older post and beam railing which is considered a barrier, but it does not meet current crashworthy standards. This is being further investigated for needed upgrades. The barriers at the other 2 locations meet current crashworthy requirements. Based on the descriptions and diagrams in the crash reports, all 3 crashes involved impacts at unusually steep angles outside the range for which barriers are designed and tested.

2.6.4 Bridge Approaches to Bridges over Water

Bridge approaches typically are provided with barriers to shield the steep slopes on bridge approach embankments and to shield the blunt end of a bridge railing. This in turn also provides shielding of the water body.

Chloe's Law: There were 3 drowning crashes at bridge approaches as indicated in Tables 2 and 4. Upgrades to the approach barriers to bring these barriers up to current standards are planned.

2.6.5 Side Road Bridges

Side road bridges located immediately adjacent to the intersection can be problematic. As with bridges and bridge approaches these locations are typically shielded. Yet at these locations, barriers parallel to the side road and/or wrapped around the relatively short intersection return radii results in an undesirable orientation of the barrier as it relates to the direction of vehicular travel on the road perpendicular to the side road. An errant vehicle traveling on the road perpendicular to the side road near such an intersection is subject to near 90 degree impacts with barriers installed on the side road bridge and approaches. Design criteria requires shielding to be installed in these scenarios, but it is understood the effectiveness of these installations are less than ideal.

Chloe's Law: As indicated in Tables 2 and 4, there were 3 drowning crashes associated with side road bridges near an intersection. In one case the vehicle impacted the approach guardrail to a side road bridge head on and passed through and over the guardrail and fell into a canal. The guardrail has since been repaired/replaced. In a second case a vehicle impacted the concrete terminal end of a bridge railing and rolled over into a canal. No changes are planned to the existing bridge railing. In the third case a tractor trailer attempted to turn right onto a narrow farm road bridge but failed to swing wide enough. The trailer impacted the guardrail and as it leaned over the barrier it pulled the entire vehicle into a canal. The farm road bridge has since been removed and guardrail has been extended across the opening. No further work is planned at this site. It should be noted that barriers sufficient to handle impacts by tractor trailers are not the norm and are typically used only in special cases.

2.6.6 T-Intersections

Water bodies located perpendicular to the direction of travel that occur at T-Intersections may include most any type of water body. . Barriers are sometimes installed at these locations on the State Highway System, however they are installed primarily for the purpose of shielding hazards for vehicles travelling on the road parallel to the hazard. They are not designed to be a safety measure to address perpendicular head on impacts. It is normal expectation that vehicles approaching a T-Intersection will slow to a stop before entering the intersection or slow to 10 or 15 mph to make a safe turn. A perpendicular barrier may easily contain a vehicle traveling at this speed, but for higher speeds a barrier could cause serious or fatal injuries. For this type of crash other mitigation techniques may need to be considered, such as improved delineation, signing, object markers, lighting, addition of rumble strips approaching the intersection, etc. Ideally, the best solution would be to relocate or realign the intersection or relocate the water body so that such a condition does not exist. This would likely be cost prohibitive for most existing locations.

Chloe's Law: As indicated in Tables 2 and 4, there were 4 drowning crashes at T-Intersections. There were 2 crashes where concrete barriers were installed in conformance with FDOT design criteria to shield a hazardous drop-off involving a water body for vehicles traveling parallel to the water body. In both crashes the vehicle impacted the barrier head on and rolled or vaulted over the barrier into the adjacent water body. There were no barriers for the other 2 cases. In the other 2 cases with no barriers, the vehicle proceeded straight across the intersection and into the water body. In one of these cases, barriers are planned to be added to address vehicles travelling parallel to the barrier. Reasons for not adding a barrier at the other crash location without an existing barrier are provided in Appendix A (Crash Number 863193390).

FDOT is reviewing requirements for signing and marking or other treatments that can be used at T-Intersections to mitigate the possibility of crashes of this type. .

2.7 Comparison of "Ran Off Road into Water" crashes with other "Ran Off Road" Crashes

Table 12 was prepared from a previous study completed in 2013. As indicated in Table 12, of the roadside objects shown, the highest number of fatalities was "motor vehicle hit tree/shrubbery". Ran off Road into Water fatal crashes ranked 12th, well below fatal crashes where motor vehicle hit guardrail (rank 3rd) and motor vehicle hit concrete barrier wall (rank 4th).

Table 12
Ran Off Road Crashes by "Harmful Event 1 At Fault"
Florida State Roads - 2003 through 2011
Ranked by Total Fatalities (K) in Descending Order

Rank by No. of Fatalities	Harmful Event Code	Harmful Event 1 At Fault	K Fatal Crashes	A Serious Injury	B Mod Injury	C Minor Injury	O Prop Damage	Total Crashes
1	22	MV hit tree/shrubbery	436	2118	3283	2735	5014	13586
2	29	MV ran into ditch/culvert	317	1953	3130	2825	5088	13313
3	18	MV hit guardrail	313	2186	4857	5411	11121	23888
4	20	MV hit concrete barrier wall	195	1777	4815	5744	8941	21472
5	27	MV hit other fixed object	176	616	1050	891	3040	5773
6	17	MV hit utility pole/light pole	171	790	1601	1428	3822	7812
7	39	median crossover	168	413	616	407	728	2332
8	16	MV hit sign/sign post	129	468	906	870	3439	5812
9	8	collision w/ parked car	67	290	604	601	3595	5157
10	21	MV hit bridge/pier/abutment/rail	62	149	315	249	706	1481
11	19	MV hit fence	60	264	561	580	2042	3507
12	**30**	**ran off road into water**	**60**	**232**	**498**	**510**	**965**	**2265**
13	25	collision w/ crash attenuators	21	126	261	265	602	1275
14	23	collision w/ constr barricade sign	14	55	157	138	563	927

3. Findings and Conclusions

Findings for the years July 1, 2006 through June 30, 2016:

1. There were 70 crashes into water where drowning was or may have been the cause of death (45 by drowning plus 25 "undetermined"). This averages to 7 per year.

2. Crash types involving death by drowning generally fall into 6 different crash types:

Crash Scenario	No of Crashes	Average per Year	Percent of Total
Parallel Water Bodies	54	5.4	77.1
Cross Drain Culvert	3	0.3	4.3
Bridges over Water	3	0.3	4.3
Bridge Approaches	3	0.3	4.3
Side Road Bridges	3	0.3	4.3
Perpendicular at T-Intersections	4	0.4	5.7
Total	70	7.0	100.0

3. The majority of drowning crashes occur in parallel water bodies (54 of 70 = 77.1%).

4. The majority of drowning crashes occur on high speed roadways (48 of 70 = 68.6%).

5. The majority of drowning crashes occur in canals parallel to the roadway (39 of 70 = 55.7%). This is consistent with the highest frequency of drowning crashes which occurred in Miami-Dade, Palm Beach, Broward and Collier Counties, all which have substantial roadway mileage adjacent to canals and other water bodies.

6. The presence of barriers to shield water bodies does not eliminate drowning crashes. There were 28 of 70 (40%) drowning crashes at locations where the water body was shielded. This includes crashes into water bodies at offset distances up to 125 feet.

7. There were 42 of 70 (60%) drowning crashes at locations where the water body was not shielded. This averages to 4.2 per year.

8. On high speed roadways, there were 23 drowning crashes into unshielded parallel water bodies located 60 feet or more from the travel lane. This included 5 where the water body was located 100 feet or more from the travel lane.

9. On urban roadways which are generally low speed, there were 5 drowning crashes into unshielded parallel water bodies located more than 40 or 50 feet

from the travel lane. This included 2 where the water body was located 100 feet or more from the travel lane.

10. There were 13 drowning crashes involving water bodies that were less than 1000 feet long measured parallel to the roadway. Except for 3 that occurred at cross drains with parallel lengths measuring 30, 36 and 40 feet, the shortest parallel length was 200 feet.

Conclusions for the years July 1, 2006 through June 30, 2016:

1. This study confirms FDOT's existing criteria for shielding parallel water bodies is cost effective and exceeds requirements commonly used throughout the nation. To add even more stringent requirements runs the risk of unnecessarily increasing the overall frequency of crashes with minimal gain in terms of reducing drowning crashes.

2. Barriers should not be used for the sole purpose of shielding water bodies perpendicular to the direction of travel at T-Intersections. For this type of crash other mitigation techniques may need to be considered, such as improved delineation, signing, object markers, lighting, addition of rumble strips approaching the intersection, etc. Ideally, the best solution would be to relocate or realign the intersection or relocate the water body so that such a condition does not exist. This would likely be cost prohibitive for most existing locations, but should be a consideration on new and reconstruction projects.

Chloe's Law - Review and Analysis of Crashes

Appendix A

Exemptions to Barrier Requirements

Prepared by

James A. Mills, PE
Pavement Analytics, LLC

December 20, 2016

Exemptions to Barrier Requirements

Drowning Crash Locations where Barriers are Not Recommended

A.1. Introduction

Chloe's Law includes the following provision allowing for exemptions to the requirement to install roadside barriers to shield water bodies contiguous with state roads at locations where a death due to drowning resulted from a motor vehicle accident:

"This requirement does not apply to any location at which the department's chief engineer determines, based on engineering principles, that installation of a barrier would increase the risk of injury to motorists traveling on the adjacent state road."

This appendix includes a brief description of the engineering principles used in making decisions on the use of roadside barriers. This appendix also identifies the 5 drowning crash locations where barriers are not recommended along with the Chief Engineer's approval and associated documentation for each location.

A.2. Engineering Principles for use of Barriers

The engineering principles used to comply with Chloe's Law are outlined in FDOT's design criteria. Current FDOT design criteria calls for barriers to be installed to shield a variety of roadside hazards including water bodies when minimum offset distance requirements to the hazard cannot be met. In cases where these distances cannot be met and it is not possible to install a barrier due to site conditions, lack of right of way, and/or extreme expense, FDOT provides the following direction in the FDOT Plans Preparation Manual for treatment of roadside hazards quoted as follows, listed in order of priority:

1. *Eliminate the hazard.*
    a. *Remove the hazard.*
    b. *Relocate the hazard outside the clear zone.*
    c. *Make the hazard traversable or crashworthy.*
2. *Shield the hazard with a longitudinal barrier or crash cushion.*
3. *Leave the hazard unshielded when any of the following apply:*
    - *Longitudinal barrier or crash cushion would be a greater hazard than the hazard to be shielded; or*
    - *The likelihood of striking the hazard is negligible; or*
    - *The expense of shielding the hazard outweighs the benefits in terms of crash reduction as determined through the use of RSAP* (Roadside Safety Analysis Program) *or HSM* (Highway Safety Manual) *analyses.*

If crash data or safety reports indicate that early treatment of the hazards will result in fewer or less severe crashes, implementing those treatments should be the first order of work

The above FDOT direction is based on national highway design practice and guidance supported by considerable research and documented in the AASHTO Roadside Design Guide. In many ways, FDOT criteria is more stringent than nationally accepted criteria exceeding minimum requirements.

It has been well established that even though roadside barriers are designed and tested to meet specific crash test criteria for a range of impact conditions, there are impacts with barriers that sometimes can and do result in serious and/or fatal injury. To shield a hazard with a barrier requires the barrier be installed closer to the roadway than the hazard and proper shielding requires the barrier extend in advance of the hazard for a specified distance. Given the barrier is closer to the roadway than the hazard, and the barrier extends for a greater distance along the roadway than the hazard, the probability of impact with the barrier is greater than impacting the hazard if no barrier was present. While the presence of a barrier will result in more crashes, if it can be shown over the life of a project there will be lower overall crash costs with fewer severe injury and fatal crashes, installing a barrier is often justified.

There are engineering methods to estimate societal crash costs associated with impacts to barriers and a variety of common roadside hazards. There are also methods for estimating the probability of impacts with a barrier vs. the probability of impact with a hazard depending on offset distances and length of exposure. The Roadside Safety Analysis Program (RSAP) is a computer program that can be used to conduct such an analysis and provide benefit cost ratios for installing barriers. Results of conducting a benefit cost analysis are used in combination with information on historical crash experience, roadway and site conditions, and experienced engineering judgement to make a decisions on installing barriers.

The basic equation used by RSAP for determining the benefit of installing a barrier is as follows:

$$B/C\ Ratio = \frac{CC_1 - CC_2}{DC_2 - DC_1}$$

Where:

B/C Ratio	=	**B**enefit **C**ost ratio of Alternative **2** compared to Alternative **1**
CC_1, CC_2	=	annualized **C**rash **C**ost of Alternatives **1** and **2**
DC_1, DC_2	=	annualized **D**irect **C**ost of Alternatives **1** and **2**, including construction, maintenance and repair costs.

A.3. Drowning Crash Locations where Barriers are Not Recommended

The 5 crash locations indicated in Table 1 of the report where barriers are not recommended based on engineering principles are summarized in Table A-1.

Table A-1
Drowning Crash Locations where Barriers are Not Recommended

Crash Number	Year	County	Road	Type Road	Brief Description	Engineering Principles Applied
735819460	2006	Brevard	SR 405 approx 2000 feet east of Windover Trail	Urban 4-Lane Divided Roadway	Vehicle crossed/overturned across the median and opposing roadway and into a drainage channel beyond the endwall of a box culvert.	Benefit Cost Analysis
771895050	2007	Brevard	I-95 NB approx 1 mile south of SR 519	6-Lane Limited Access	Vehicle left the roadway to the right crossing the shoulder and side slopes and continuing through a fence at the right of way line into an offsite canal.	Benefit Cost Analysis
774477960	2009	Brevard	I-95 NB approx 1.5 miles north of SR 518	6-Lane Limited Access	Motorcycle left roadway to the right crossing the shoulder and front slope and into a roadside ditch with standing water.	Benefit Cost Analysis
819964560	2012	Taylor	SR 30/US 98 approx 7.5 miles west of US 27 in Perry	Rural 2-Lane Roadway	Vehicle traveling westbound left the right side of the roadway overturning into a roadside ditch with standing water.	Benefit Cost Analysis combined with other considerations
863193390	2016	Pinellas	SR 686 East Bay Drive at Alt Keene Road	Urban 6-Lane Roadway	Vehicle traveling southbound on Alt Keene Road crossed the T intersection at SR 686 without stopping continuing across an open field approx 280 feet into a small lake.	Engineering review of site conditions and assessment of proper application of barrier in addressing this type of crash.

The Chief Engineer's approval and associated documentation for each location are included in this appendix as follows.

Crash No. 735819460 Page 1 of 4

Location: SR 405 approximately 2000 feet east of Windover Trail in Brevard County

A barrier to shield the cross drain endwall and associated water body is not recommended for the following reasons.

- A benefit cost analysis was conducted using the Roadside Safety Analysis Program (RSAP) to assess the merits of installing guardrail 12 feet from the travel lane. The resulting Benefit Cost Ratio was determined to be negative 0.45. This indicates crash costs associated with predicted impacts with the barrier exceeds the crash costs associated with predicted impacts with the end wall or water, increasing the risk of injury to motorists traveling on the roadway.
- Barriers are designed and tested for impacts by vehicles in an upright position. The vehicle in this crash was rolling as it crossed the median and opposing roadway and it is highly questionable if a barrier would have kept the vehicle from entering the water.
- The existing endwall and water body are located 30 feet from the nearest travel lane which meets/exceeds FDOT design criteria.

Approved: for [signature] Date: 1-3-17
Courtney Drummond, PE
Chief Engineer
Florida Department of Transportation

Attachments: Excerpts from Crash Report – Crash Narrative and Diagram (2 pages)
Aerial Photo and Street View of Crash Location (1 page)
Summary of Road Characteristics and RSAP Results (1 page)

Crash No. 735819460 Page 2 of 4

Excerpt from Crash Report - Diagram

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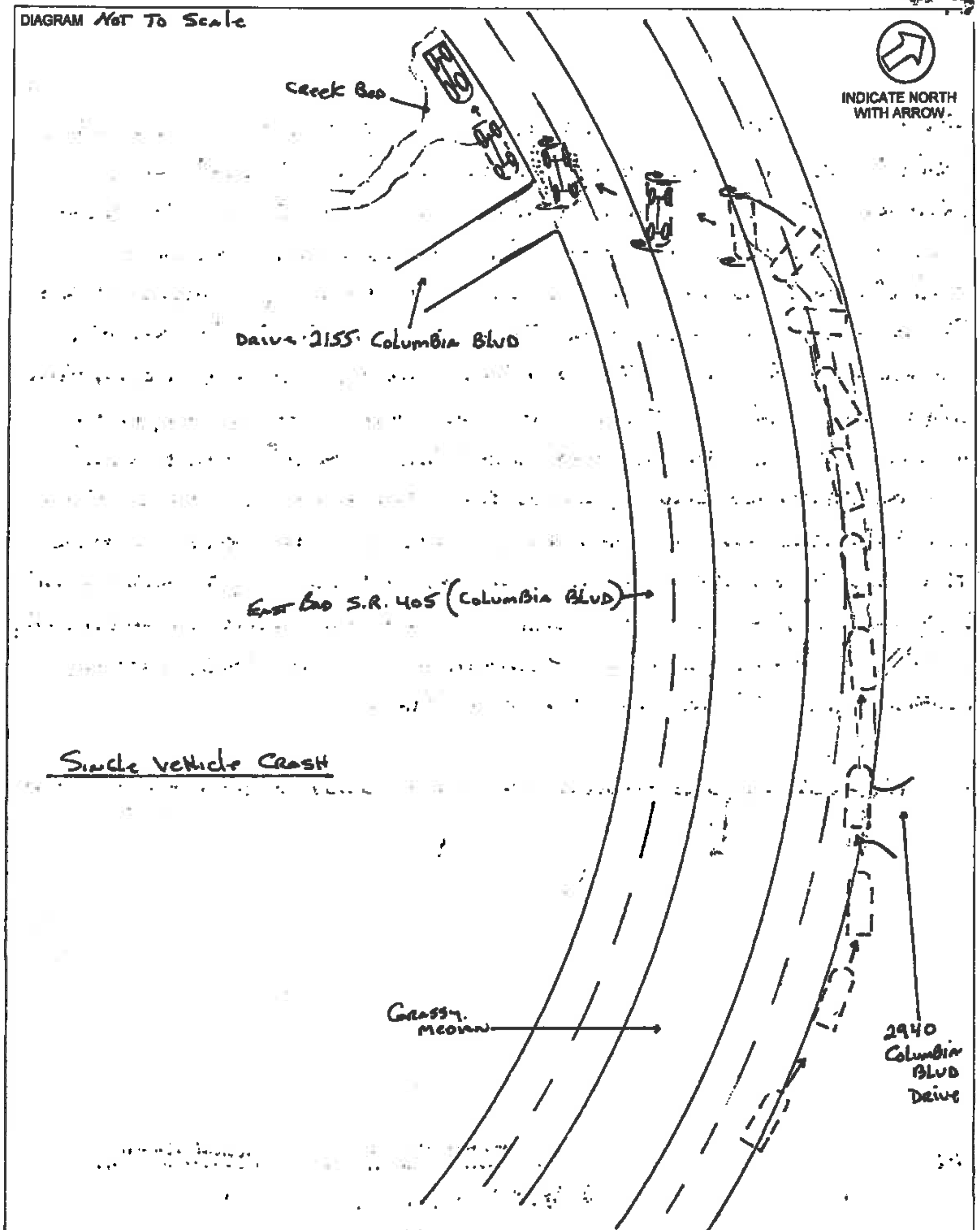
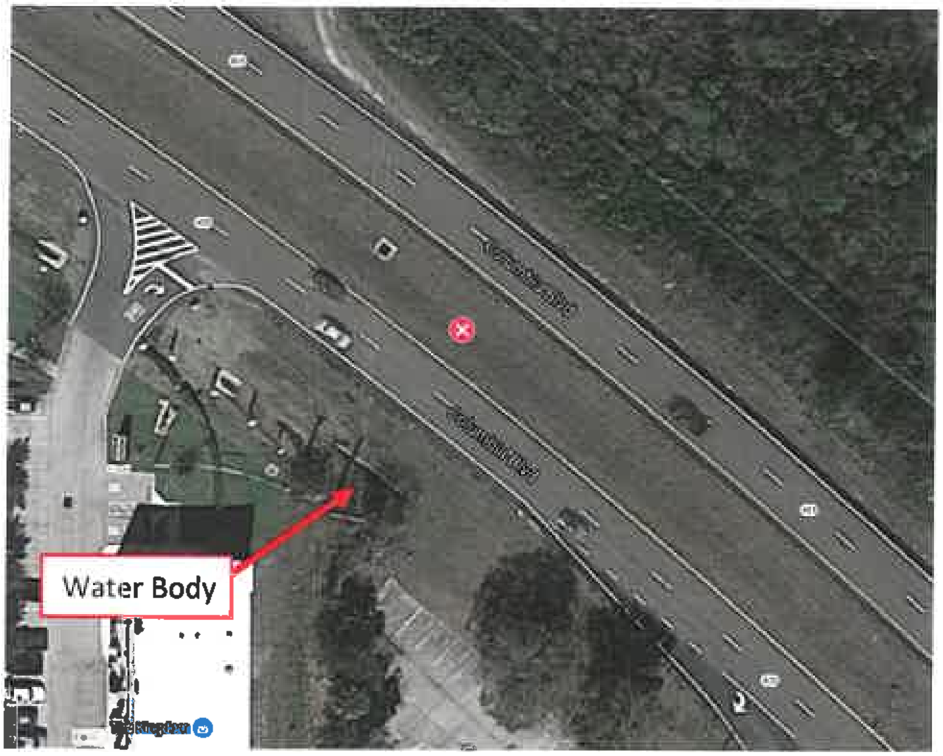


Page 4 of 4

Crash No. 735819460 Page 3 of 4

Aerial Photo of Crash Location



Street View of Crash Location

Crash Number 735819460 Page 4 of 4

Summary of Road Characteristics and RSAP Results

Year of Crash: 2006

Location: SR 405 (Columbia Boulevard), 2000 feet east of Windover Trail
Titusville, FL
Brevard County

Vehicle Type: Automobile

Roadway Type: Urban Multilane (originally Rural Multilane)

Cross Section:
- No. of Lanes: 4-Lane Divided
- Lane Width: 12 feet
- Median Width: 40 feet
- Shoulder Width: 10 feet

Traffic:
- ADT: 14,600 vehicles per day
- Percent Trucks: 6.1 %
- Design Speed: Unknown (estimated at 70 mph based on curve geometrics)
- Posted Speed: 45 mph

Alignment at Crash Location:
- Horizontal: Curve Radius 2864.93 feet
  Superelevation 0.074 feet/feet
- Vertical: Flat

Water Body/Crash Type:
- Lateral Ditch/Canal at Cross Drain Culvert at 4 x 5 Concrete Box Culvert
- Offset from Travel Lane: 30 feet
- Length Parallel to Road: 36 feet
- No existing barrier

RSAP Results:

Alternative Description	Crashes per Year	Annualized Crash Cost	Construction Cost	Annualized Construction Cost	Annualized Repair Cost	Total Direct Costs
Alt. 1 – Do Nothing	0.35	$ 40,968.00	0.00	0.00	0.00	0.00
Alt. 2 – 150' W-Beam Guardrail	0.47	$ 42,193.00	$ 35,237.00	$ 2,593.00	$ 104.00	$ 2,697.00
Difference		- $ 1,225.00		$ 2,593.00	$ 104.00	$ 2,697.00
Benefit Cost Ratio	- 0.45					

Crash No. 771895050 Page 1 of 4

Location: I-95 NB approximately 1 mile south of SR 519

A barrier to shield the offsite canal which is located approximately 110 feet from the nearest travel lane is not recommended for the following reasons.

- A benefit cost analysis was conducted using the Roadside Safety Analysis Program (RSAP) to assess the merits of installing guardrail 40 feet from the travel lane. The resulting Benefit Cost Ratio was determined to be negative 0.46. This indicates crash costs associated with predicted impacts with the barrier exceeds the crash costs associated with predicted impacts with the canal, increasing the risk of injury to motorists traveling on the roadway.
- The existing canal is located 110 feet from the nearest travel lane which meets/exceeds FDOT design criteria.

Approved: for Courtney Drummond, PE
Chief Engineer
Florida Department of Transportation

Date: 1-3-17

Attachments: Excerpts from Crash Report – Crash Narrative and Diagram (2 pages)
Aerial Photo and Street View of Crash Location (1 page)
Summary of Road Characteristics and RSAP Results (1 page)

Crash No. 771895050 Page 2 of 4
Excerpt from Crash Report - Diagram

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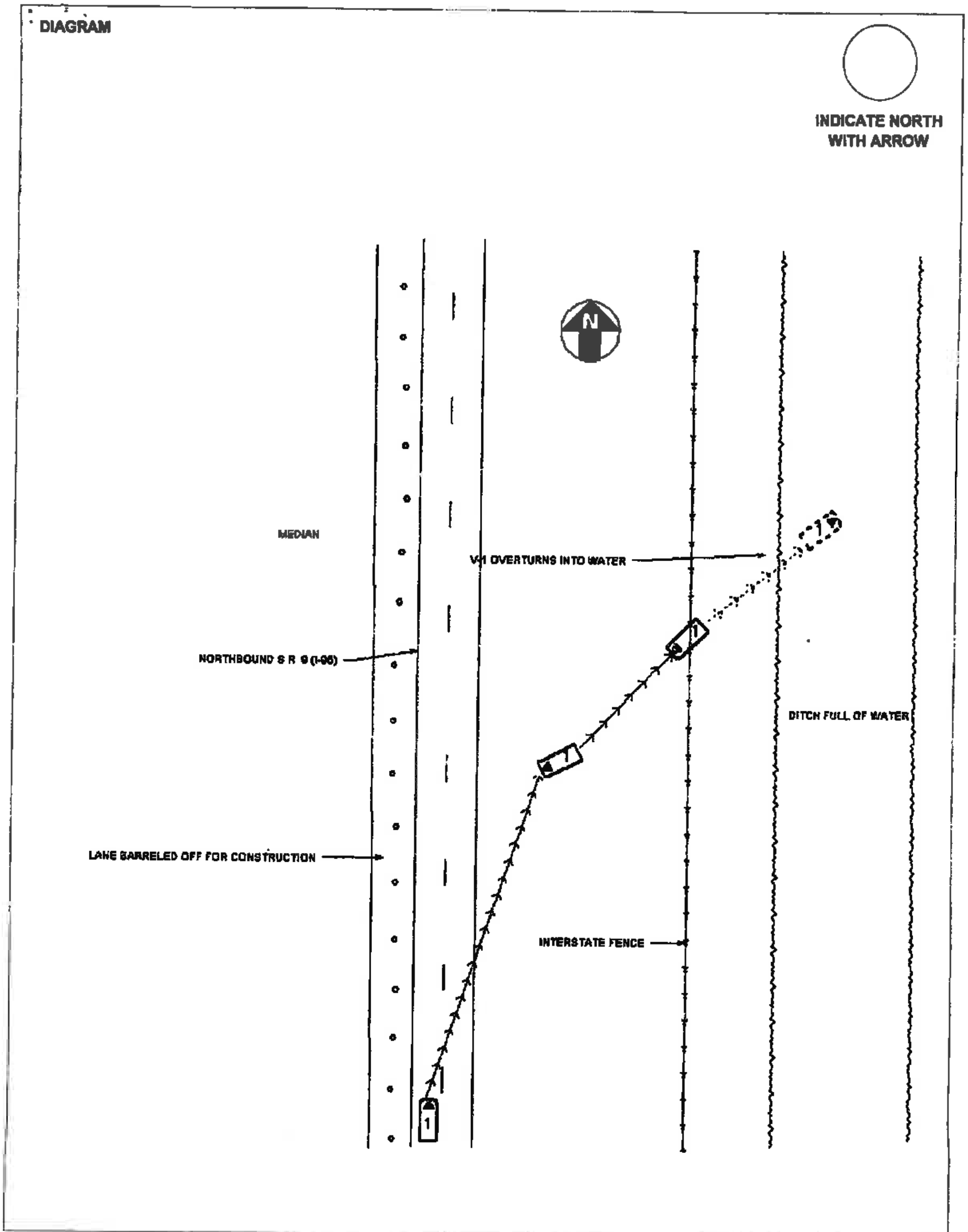
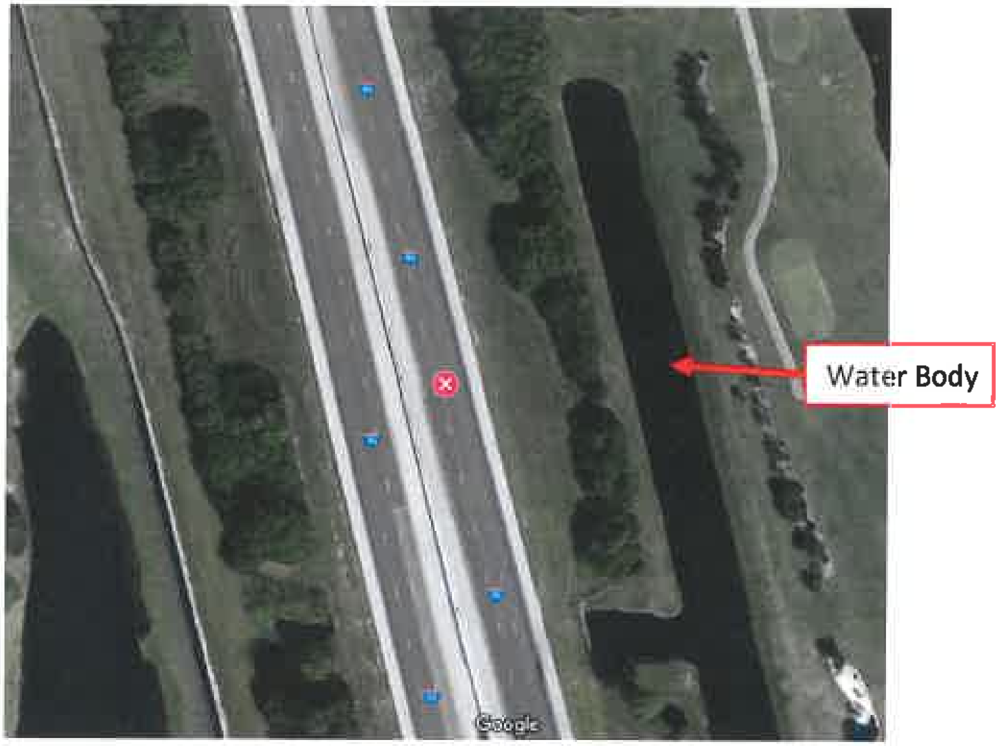


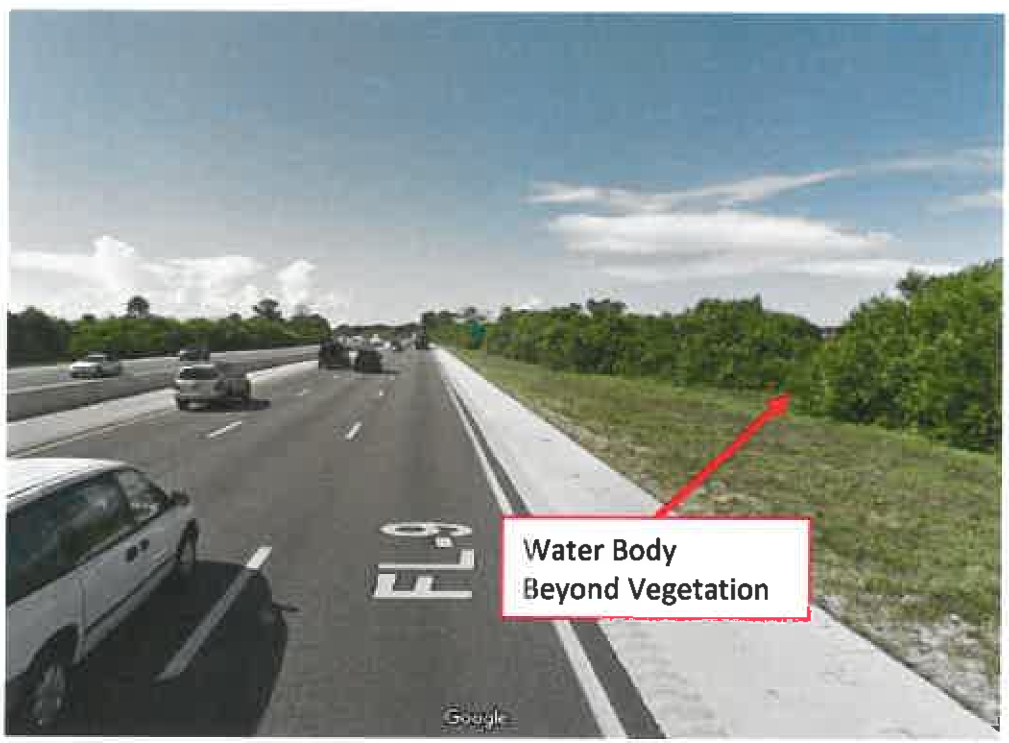
Page 4 of 4 Pages

Crash No. 771895050 Page 3 of 4

Aerial Photo of Crash Location



Street View of Crash Location



Crash Number 771895050 Page 4 of 4

Year of Crash: 2007

Location: I-95 North Bound – 1 mile south of SR 519
Rockledge, FL
Brevard County

Vehicle Type: Automobile

Roadway Type: Limited Access - Interstate

Cross Section:
- No. of Lanes: 6-Lane Divided (4-Lanes at time of crash)
- Lane Width: 12 feet
- Median Width: 40 feet with median barrier
- Shoulder Width: 12 feet

Traffic:
- ADT: 56,000 vehicles per day
- Percent Trucks: 11.0 %
- Design Speed: 70 mph
- Posted Speed: 70 mph

Alignment at Crash Location:
- Horizontal: Straight
- Vertical: Flat

Water Body/Crash Type
- Canal parallel to roadway
- Offset from Travel Lane: 110 feet
- Length Parallel to Road: 4370 feet
- No existing barrier shielding canal

RSAP Results

Alternative Description	Crashes per Year	Annualized Crash Cost	Construction Cost	Annualized Construction Cost	Annualized Repair Cost	Total Direct Costs
Alt. 1 – Do Nothing	1.54	$ 83,081.00	0.00	0.00	$ 1,594.00	$ 1,594.00
Alt. 2 – 4600' W-Beam Guardrail	2.39	$ 97,038.00	$ 400,000.00	$ 29,433.00	$ 2,642.00	$ 32,075.00
Difference		- $ 13,957.00		$ 29,433.00	$1,048.00	$ 30,481.00
Benefit Cost Ratio	- 0.46					

*Annualized Repair Cost for Do Nothing Alternative is associated with repair cost to median guardrail.

Crash No. 774477960 Page 1 of 4

Location: I-95 NB approximately 1.5 miles north of SR 518

A barrier to shield the roadside ditch located approximately 36 feet from the nearest travel lane is not recommended for the following reasons.

- A benefit cost analysis was conducted using the Roadside Safety Analysis Program (RSAP) to assess the merits of installing guardrail at the shoulder point 12 feet from the travel lane. The resulting Benefit Cost Ratio was determined to be 0.45. This indicates crash costs associated with predicted impacts with the barrier are only slightly less than the crash costs associated with predicted impacts with the water body. The reduction in crash costs provided by the barrier however is less than the cost of installing and maintaining the barrier.
- This crash involved a motorcycle and the driver was ejected. It is highly questionable whether a barrier would have provided any benefit in the resulting outcome. Current barrier types used in the United States are not designed for motorcycle impacts.
- This roadside ditch is outside the clear zone. Whether this ditch should be considered a parallel water body is somewhat questionable. The water level fluctuates from 0 to approximately 3 feet deep. Vehicles remaining upright on impact would not expect to result in a drowning.
- The ditch is located approximately 36 feet from the nearest travel lane and conforms to current FDOT design criteria.

Approved: ______________________ Date: 1-3-17
Courtney Drummond, PE
Chief Engineer
Florida Department of Transportation

Attachments: Excerpts from Crash Report – Crash Narrative and Diagram (2 pages)
Aerial Photo and Street View of Crash Location (1 page)
Summary of Road Characteristics and RSAP Results (1 page)

Crash No. 774477960 Page 2 of 4

Excerpt from Crash Report - Diagram

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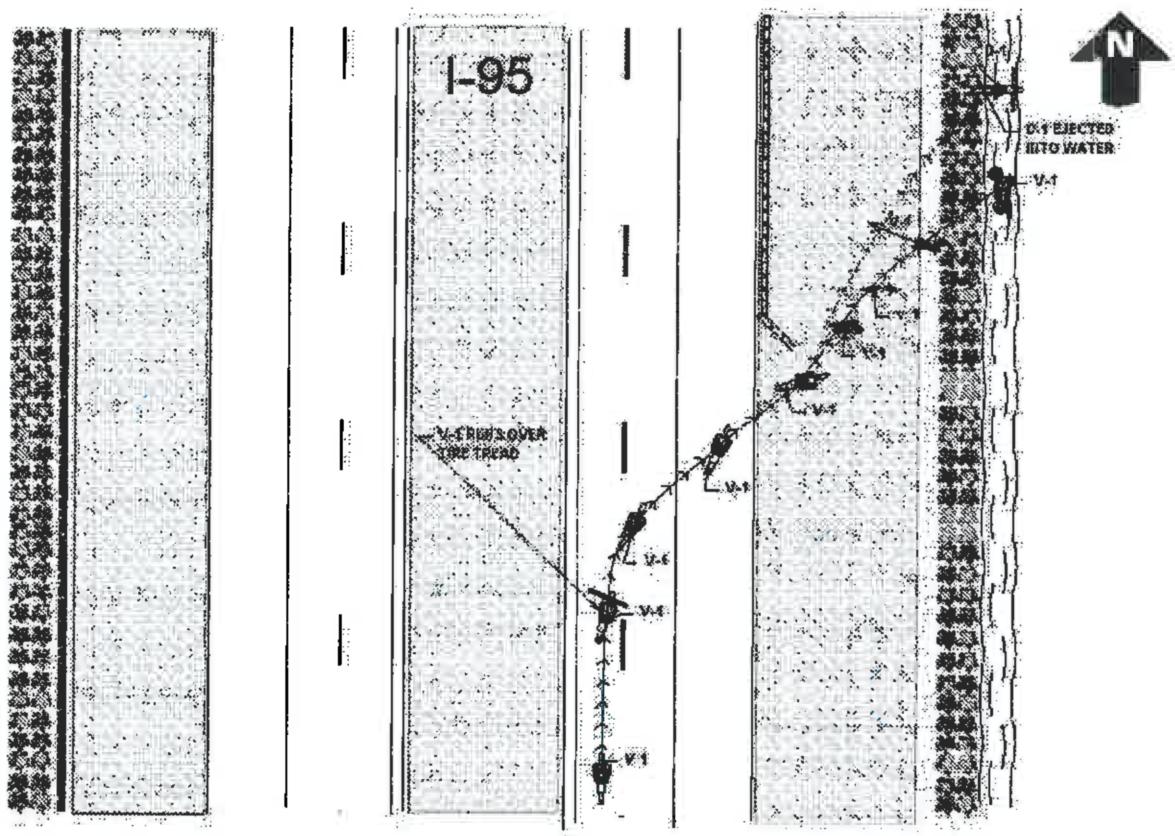
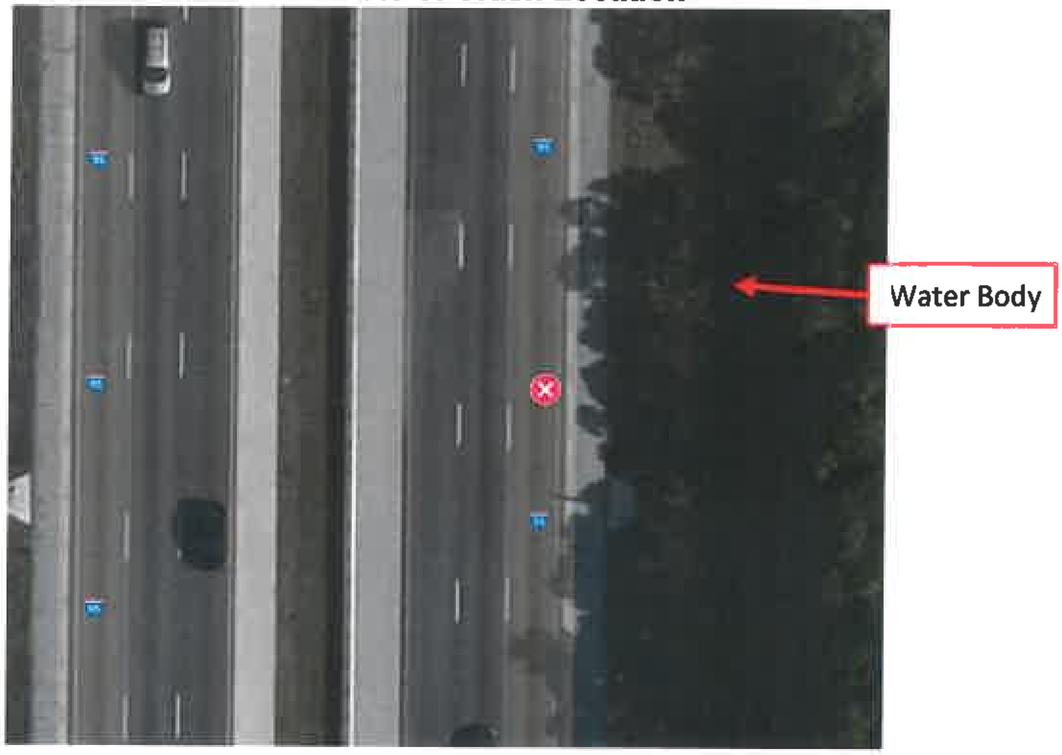


Page 4 of 8

Crash No. 774477960 Page 3 of 4

Aerial Photo of Crash Location



Street View of Crash Location

Crash Number 774477960 Page 4 of 4

Year of Crash: 2009

Location: I-95 North Bound – 1.5 miles north of SR 518 (Eau Gallie Blvd)
Melbourne, FL
Brevard County

Vehicle Type: Motorcycle

Roadway Type: Limited Access - Interstate

Cross Section:
- No. of Lanes: 6-Lane Divided (4-Lanes at time of crash)
- Lane Width: 12 feet
- Median Width: 40 feet with median barrier
- Shoulder Width: 12 feet

Traffic:
- ADT: 81,000 vehicles per day
- Percent Trucks: 22.6 %
- Design Speed: 70 mph
- Posted Speed: 70 mph

Alignment at Crash Location:
- Horizontal: Straight
- Vertical: Flat

Water Body/Crash Type
- Roadside Ditch parallel to roadway
- Offset from Travel Lane: 36 feet
- Length Parallel to Road: 4700 feet
- No existing barrier shielding roadside ditch

RSAP Results

Alternative Description	Crashes per Year	Annualized Crash Cost	Construction Cost	Annualized Construction Cost	Annualized Repair Cost	Annualized Total Direct Costs
Alt. 1 – Do Nothing	3.77	$ 363,747.00	0.00	0.00	$ 2,194.00	$ 2,194.00
Alt. 2 – 4700' W-Beam Guardrail	4.29	$ 351,629.00	$ 338,000.00	$ 24,847.00	$ 4,506.00	$ 29,353.00
Difference		$ 12,118.00		$ 24,847.00	$ 2,312.00	$ 27,159.00
Benefit Cost Ratio	0.45					

*Annualized Repair Cost for Do Nothing Alternative is associated with repair cost to median guardrail.

Crash No. 819964560 Page 1 of 4

Location: SR 30/US 98 approximately 7.5 miles west of US 27 in Perry

A barrier to shield the roadside ditch located approximately 26 from the nearest travel lane is not recommended for the following reasons.

- A benefit cost analysis was conducted using the Roadside Safety Analysis Program (RSAP) to assess the merits of installing guardrail at the shoulder point 10 feet from the travel lane. The resulting Benefit Cost Ratio was determined to be a 2.87. This suggests it would be cost beneficial to install barriers. However, whether this ditch should be considered as having the same level of severity as a canal or other water body 3 feet deep and greater is questionable. The typical water depth varies from 0.5 to 0.7 feet. RSAP assigns a single severity level to water that does not vary depending on water depth. Engineering judgement is required to determine whether to code a shallow water ditch as a water hazard in the program. Running RSAP without coding this ditch as a water hazard results in a Benefit Cost Ratio of negative 2.73. A true benefit cost ratio for installing a barrier is likely somewhere in between. Also to be considered is that when coded as a water hazard, RSAP predicts that crashes will double given the proximity of the barrier to the travel lane.
- Barriers are designed and tested for impacts by vehicles in an upright position. The vehicle in this crash began to spin before leaving the pavement and began to rollover as it entered the shoulder and it is highly questionable if a barrier would have kept the vehicle from entering the water.
- SR 30/US 98 in this area extends for many miles in low lying areas. The ditch bottom fluctuates somewhat and it is difficult to identify the limits of shielding for locations similar to those present at the site of the crash. The District estimated this condition existed for 6.7 miles on both sides. It is noteworthy that no other drowning death has occurred on this roadway in 10 years.
- Instead of installing barriers at this crash location, consideration will be given to installing audible and vibratory pavement markings to alert drivers and mitigate lane departures.

Approved: [signature] Date: 1-3-17

Courtney Drummond, PE
Chief Engineer
Florida Department of Transportation

Attachments: Excerpts from Crash Report – Crash Narrative and Diagram (2 pages)
Aerial Photo and Street View of Crash Location (1 page)
Summary of Road Characteristics and RSAP Results (1 page)

Crash No. 819964560 Page 2 of 4

Excerpt from Crash Report - Diagram

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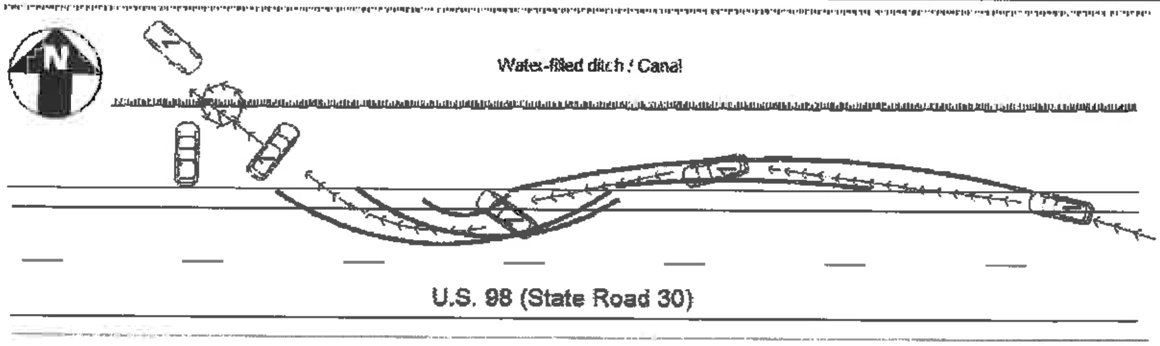

Page 3 of 3

Crash Number 819964560 Page 3 of 4

Aerial Photo of Crash Location

Street View of Crash Location

Crash Number 819964560 Page 4 of 4

Year of Crash: 2012

Location: SR 30 (US 98) 7.5 Miles West of US 27, Perry FL
Taylor County

Vehicle Type: Small SUV

Roadway Type: Rural 2-Lane

Cross Section:
- No. of Lanes: 2-Lane
- Lane Width: 12 feet
- Shoulder Width: 10 feet

Traffic:
- ADT: 2,400 vehicles per day
- Percent Trucks: 1.3 %
- Design Speed: 90 kph (55 mph)
- Posted Speed: 60 mph

Alignment at Crash Location:
- Horizontal: Straight
- Vertical: Flat

Water Body/Crash Type
- Roadside Ditch parallel to roadway
- Offset from Travel Lane: 26 feet
- Length Parallel to Road: 6.7 miles each side
- No existing barrier shielding roadside ditch

RSAP Results

Based on Costs Per Mile:

Alternative Description	Crashes per Year	Annualized Crash Cost	Construction Cost	Annualized Construction Cost	Annualized Repair Cost	Total Direct Costs
Alt. 1 – Do Nothing	1.88	$ 170,308.00	0.00	0.00	$ 0.00	$ 0.00
Alt. 2 – 1 mi W-Beam Guardrail	3.67	$ 85,198.00	$ 354,000.00	$ 26,048.00	$ 3,592.00	$ 29,640.00
Difference		$ 85,110.00		$ 26,048.00	$ 3,592.00	$ 29,640.00
Benefit Cost Ratio	2.87					

Crash No. 863193390 Page 1 of 4

Location: SR 686 East Bay Drive at Alt Keene Road in Pinellas County.

This crash location is at a T-Intersection. Alt Keene Road is a local jurisdiction road that intersects SR 686. A barrier is not recommended on SR 686 for the following reasons:

- A driveway to private property is located in the area where the barrier would be installed.
- Placement of a barrier on the south side of SR 686 perpendicular to Alt Keene Road to shield motorists traveling southbound on Alt Keene Road from entering the pond is not the proper application of a roadside barrier. Roadside barriers are designed and tested for vehicles impacting at 25 degrees or less. The safety performance of a barrier placed perpendicular to the direction of travel where impacts would occur at or near 90 degrees is questionable at best. Barriers impacted at 90 degrees can be penetrated or overtopped depending on vehicle size, impact speed, and approach conditions. If successful at stopping a vehicle impacting at this angle, the resulting impact would likely be as severe as impacting most any type of fixed roadside object.
- Installation of a barrier would increase the risk of impact to motorists traveling east and west on SR 686.
- This particular crash is somewhat unusual. The pond is approximately 280 feet from the roadway. Standards based on engineering principles supported by research show for a roadway of this type that 280 feet exceeds the distance required for an errant vehicle to stop or recover. Also of note, there has been no other reported crash at this location for the 10 year period between 2006 and 2016 resulting in a fatality involving this small lake.

Approved: ______________________ Date: 1-3-17
Courtney Drummond, PE
Chief Engineer
Florida Department of Transportation

Attachments: Excerpts from Crash Report – Crash Narrative and Diagram (2 pages)
Aerial Photo and Street View of Crash Location (1 page)

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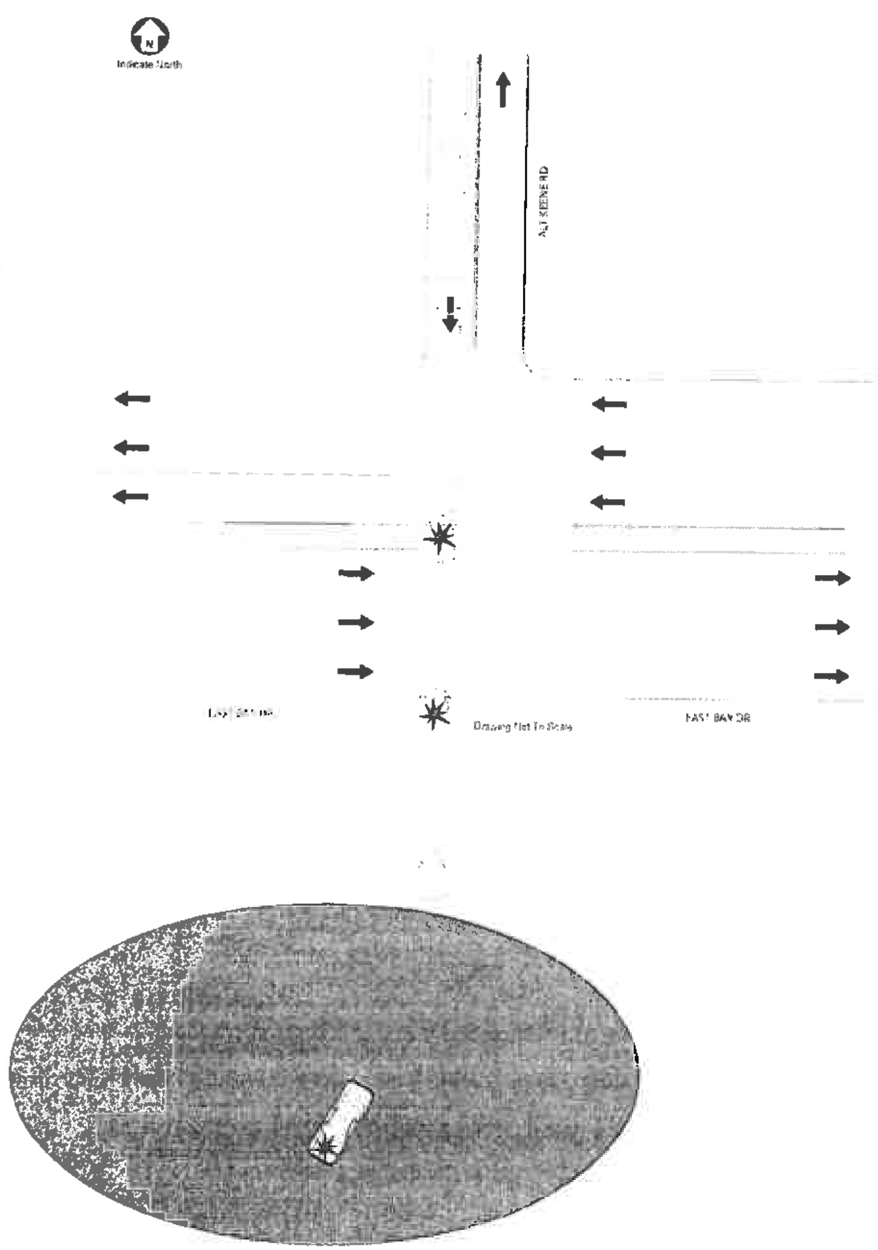
Excerpt from Crash Report – Diagram

DOCUMENTS WITH THIS NOTICE SHALL BE USED ONLY FOR PURPOSES OF THE FDOT. SEE TITLE 23, USC, SECTION 409.

DIAGRAM	REPORTING AGENCY CASE NUMBER	HSMV CRASH REPORT NUMBER
	16-004412	86319339



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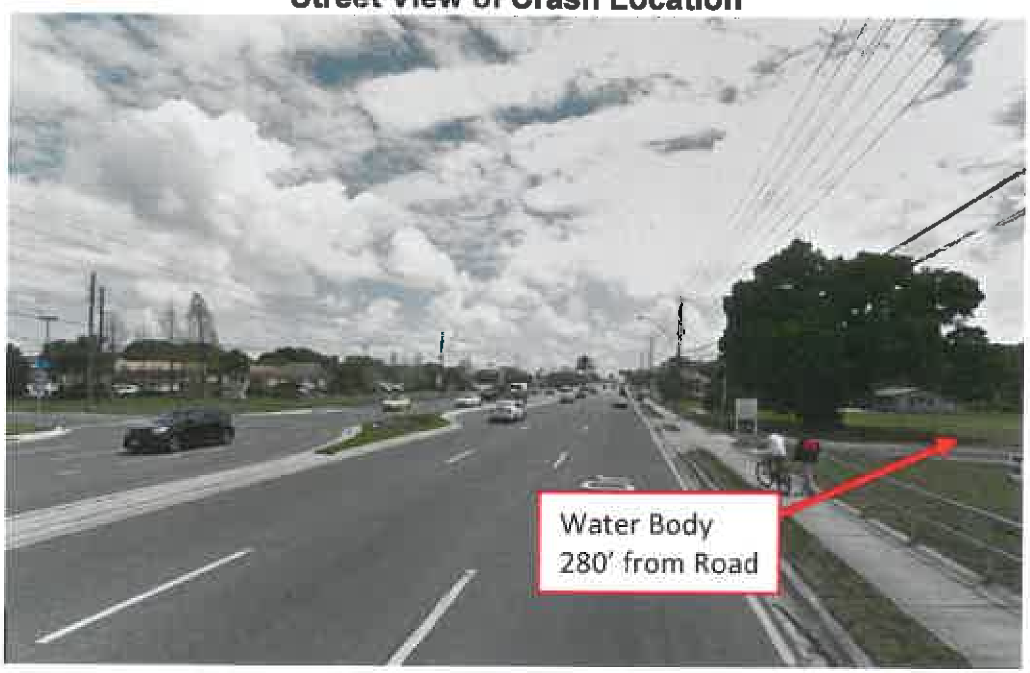
Aerial Photo of Crash Location

Street View of Crash Location



Chloe's Law - Review and Analysis of Crashes

Appendix B

Status of Barrier Installations at Drowning Crash Locations

Prepared by

James A. Mills, PE
Pavement Analytics, LLC

December 20, 2016

Status of Barrier Installations at Drowning Crash Locations

Note: At some locations identified for barriers to be installed, in lieu of adding a barrier, other improvements will be made to relocate or eliminate water body.

Crash Report Form Number	Calendar Year	County	Barrier In Place at Time of Crash	Barrier Added since Crash	Barrier to be Installed by June 30, 2018
702999460	2006	Palm Beach	Yes		Existing
702999460	2006	Palm Beach	Yes		Existing
704390320	2006	St. Lucie	No	Yes	Existing
735819460	2006	Brevard	No		Exemption
744761450	2006	Palm Beach	No	Yes	Existing
759669110	2006	Palm Beach	No	Yes	Existing
759987560	2006	Pinellas	No	Yes	Existing
760217880	2006	Palm Beach	Yes		Existing
769319560	2006	Miami-Dade	No		Yes
769329050	2006	Miami-Dade	No	Yes	Existing
769335680	2006	Miami-Dade	No		Yes
769523630	2006	Manatee	Yes		Existing
769567990	2006	Hendry	Yes		Existing
770283600	2006	Broward	No	Noise Wall	Existing
770347540	2006	Miami-Dade	No	Yes	Existing
770516580	2006	Broward	No		Yes
733073020	2007	Miami-Dade	No	Yes	Existing
736123770	2007	Brevard	No		Yes
767883470	2007	Orange	Yes		Existing
768807270	2007	Pasco	Yes		Existing
769559650	2007	Sarasota	No		Yes
769652340	2007	Collier	No		Yes
770024720	2007	Franklin	No		Yes
770283780	2007	Broward	No	Yes	Existing
770359140	2007	Palm Beach	Yes		Existing
770527690	2007	Palm Beach	No	Yes	Existing
770540210	2007	Broward	No		Yes
771895050	2007	Brevard	No		Exemption
739600600	2008	Seminole	Yes		Existing
741576400	2008	Hillsborough	Yes		Existing
765886920	2008	Orange	Yes		Existing
767410340	2008	Seminole	No		Yes
769537910	2008	Lee	Yes		Existing
770410130	2008	Miami-Dade	No		Yes
770410140	2008	Miami-Dade	Yes		Existing
770720530	2008	Broward	No		Yes
772077460	2008	Miami-Dade	Yes		Existing

Status of Barrier Installations at Drowning Crash Locations Note: At some locations identified for barriers to be installed, in lieu of adding a barrier, other improvements will be made to relocate or eliminate water body.					
Crash Report Form Number	**Calendar Year**	**County**	**Barrier In Place at Time of Crash**	**Barrier Added since Crash**	**Barrier to be Installed by June 30, 2018**
914599720	2008	Broward	No		Yes
704879360	2009	Palm Beach	No	Yes	Existing
770316560	2009	St. Lucie	Yes		Existing
774477960	2009	Brevard	No		Exemption
704879500	2010	Palm Beach	No	Yes	Existing
704879640	2010	Palm Beach	No	Yes	Existing
769783280	2010	Duval	Yes		Existing
770498410	2010	Palm Beach	Yes		Existing
772365710	2010	Collier	Yes		Existing
774548680	2010	Miami-Dade	Yes		Existing
819588870	2011	Orange	No		Yes
819934680	2011	Santa Rosa	Yes		Existing
819945080	2011	Miami-Dade	Yes		Existing
820148000	2011	Hillsborough	No		Yes
822506800	2011	Hillsborough	Yes		Existing
819964560	2012	Taylor	No		Exemption
820412980	2012	Miami-Dade	Yes		Existing
828189720	2012	Palm Beach	Yes		Existing
828488560	2012	Miami-Dade	No		Yes
828640870	2012	Osceola	No		Yes
820263800	2013	Duval	No		Yes
828474610	2013	Collier	No		Yes
832686520	2013	Broward	No		Yes
836457440	2013	Miami-Dade	Yes		Yes
820214900	2015	Collier	No		Yes
833360550	2015	Collier	No		Yes
845383860	2015	Palm Beach	No		Yes
845583120	2015	Palm Beach	Yes		Existing
845688830	2015	Palm Beach	Yes		Existing
848677100	2015	Miami-Dade	Yes		Existing
851999400	2015	Sarasota	No		Yes
860726710	2015	Hillsborough	Yes		Existing
844763750	2016	Volusia	No		Yes
863193390	2016	Pinellas	No		Exemption