TRANSPORTATION NEEDS REPORT

William Preston Lane Jr. Memorial (Bay) Bridge

December 2004

Volume I of II

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EXECUTIVE SUMMARY

Background

The existing Bay Bridge is the only roadway crossing of the Chesapeake Bay in Maryland. Trips across the Bay Bridge consist of two types of travel: local trips (such as work related and discretionary trips) with origins and destinations relatively close to the shores, and regional travel (such as commerce and beach traffic) with origins and destinations elsewhere in Maryland and beyond. Traffic associated with all types of trips across the Bay has been steadily increasing since the parallel spans were constructed; the original two-lane bridge was constructed in 1952 and the second three-lane bridge was constructed in 1973.

The location for the existing Bay Bridge was selected in the 1930's based on a number of factors, including the growing state highway network, ship navigation, and access to the lower Eastern Shore. Since 1952, population and job growth on both sides of the Bay have increased significantly, resulting in an increase in the volumes of local and regional trips, and increased congestion and it's associated effects (e.g., accidents, increased truck traffic, delays, environmental concerns, and others). For example, between 1970 and 2000, the population of Anne Arundel County increased from 299,825 to 491,383. The Maryland Department of Planning (MDP) projects the Anne Arundel County population to increase to 541,250 by 2015. For Queen Anne's County, between 1970 and 2000, the population increased from 18,506 to 41,456. MDP projects the population in Queen Anne's County to increase to 53,550 by 2015.

The US50/301 corridor is experiencing congestion today, and is projected to experience even higher levels of congestion in the future. Most significant are the constraints that cause eastbound delays between the Parole area in Anne Arundel County and the Bay Bridge. The Bay Bridge is a critical portion of the US 50/301 corridor that is the most susceptible to factors that can cause or exacerbate congestion. For example, because it is a bridge with no shoulders, reconstruction and rehabilitation work takes longer and creates difficulties with maintaining traffic flow.

Further, based on the current condition of the eastbound bridge deck and the projected increases in traffic volumes, it is anticipated that the deck will require rehabilitation between 2015 and 2020. Depending on the type and method of construction, the rehabilitation could require long-term single lane closures or complete nighttime bridge closures of the eastbound bridge. Because the bridge is projected to carry significantly higher traffic volumes by 2015-2020, the rehabilitation would likely result in substantial travel time delays. For example the current Average Daily Traffic (ADT) during an average weekday is 61,000 and is projected to be 86,000 by 2025, an increase of 41 percent. The ADT for a Saturday in the summer is 95,000 and is projected to grow to 135,000 by 2025, an increase of 42 percent.

Recognizing these facts, the Authority has begun studies to formulate a long-term improvement plan for the William Preston Lane Jr. Memorial (Bay) Bridge Transportation Facility Project.

Bay Bridge Needs Report

a. Initiation of the Needs Report

The Bay Bridge is owned and operated by the Authority, while the approach roadway system is predominantly owned and operated by the State Highway Administration. Portions of the approach roadways are also maintained by the local county and municipal jurisdictions. The Authority – with the cooperation of various regional planning partners, including staff from a number of metropolitan planning organizations, Maryland Department of Transportation (MDOT), Virginia Department of Transportation (VDOT) and Delaware Department of Transportation (DelDOT) – initiated a study of the Bay Bridge, to begin the process of identifying the transportation and safety needs associated with the crossing. This study resulted in the Needs Report, which is now being released.

b. Purpose and Methodology of the Needs Report

The overall purpose of the Authority's initial Needs Report was to identify the long-range improvement needs of its transportation facility project through preliminary identification of issues such as transportation demand and safety. This process has ultimately led to the conclusion that addressing the transportation and safety needs at the Bay Bridge requires consideration of other corridor and, ultimately, statewide issues. The Needs Report addresses one part of the problem: What are the needs associated with the Bay Bridge?

The first step in the Authority's Needs Report was to identify a study area. The transportation needs associated with the Bay Bridge can be separated into two major areas:

- Capacity, safety, operations, and maintenance of the bridge and toll plaza.
- Capacity, safety, operations, and maintenance of the system of roadways leading to and from the Bay Bridge.

Because the transportation needs associated with the Bay Bridge extend beyond the bridge itself, the Bay Bridge study area was defined as an area extending a distance of 5.8 miles along U.S. Route 50/301, between the Oceanic Drive overpass in Anne Arundel County and the MD 8 overpass in Queen Anne's County. Within the study limits, U.S. Route 50/301 includes the Bay Bridge, the two parallel steel bridge structures that span 4.3 miles from shore to shore across the Chesapeake Bay.

In undertaking the Needs Report, the following factors were evaluated:

- Travel Patterns
- Geometric Conditions
- Travel Demand and Traffic Operations
- Maintenance and Rehabilitation Needs
- Safety

c. Key Findings

To understand the physical limitations of the bridge, an assessment of its geometric condition in light of the latest engineering standards was conducted. An assessment of the maintenance and rehabilitation needs of the bridge, based on the Authority's Long Range Plan, was also performed. Travel demand and traffic operational analyses of the bridge and the toll plazas were also conducted. And finally, a safety analysis was conducted to understand the types and locations of accidents in the study area and their possible causes.

In general, the bridge meets current geometric design standards with the exception of the offsets between travel lanes and the bridge rails. The lack of roadside shoulders or buffer areas results in the loss of a lane or roadway closures during incident management activities including clearance of disabled vehicles. This has an impact on the vehicular capacity of the bridge.

To understand the travel patterns in the study area, an origin-destination survey was conducted for eastbound traffic traveling over the Bay Bridge on both an average weekday and an average summer weekend day. This study also revealed the percentage of truck traffic using the bridge. The origin-destination studies indicate that most of the typical summer weekend eastbound bridge traffic is traveling between the Baltimore-Washington metropolitan area and the lower Eastern Shore and between the Baltimore region and both the lower

Eastern Shore and Queen Anne's County on an average weekday. In general, the Bay Bridge carries approximately 53 percent more traffic on an average summer weekend day (95,000 vehicles) than on an average weekday (61,000 vehicles) and by 2025, the daily volumes are expected to increase to approximately 135,000 vehicles on an average summer weekend day and 86,000 vehicles on an average weekday. Trucks account for approximately five percent of total traffic on an average summer weekend day and 14 percent on an average weekday.

During a three-year study period, a total of 402 accidents occurred in the study area. Although there are no similar bridges or toll plazas to make an exact comparison, the accident statistics suggest that the study area experienced a volume of rear-end collisions significantly higher than the statewide rate for similar, rural, four-lane divided highways.

Additional Needs Data

Recognizing that the congestion issues in the US 50/301 corridor are not only related to the Bay Bridge. The Authority looked at a travel time speed study for the US 50/301 corridor in the eastbound direction conducted in May and June of 2003 as part the evaluation of a Toll Sponsorship Pilot Program. The study measured travel speeds, queues, and delays. Two distinct eastbound areas of congestion were observed.

- The first area of congestion was between the Parole area and the Severn River Bridge, with queue lengths on the order of two miles. In this section, I-97 intersects US 50/301 and the number US 50/301 eastbound lanes is reduced from four to three as the roadway approaches the Severn River Bridge. Free flowing speeds were again observed from the Severn River Bridge to two miles prior to the Bay Bridge.
- The second area of congestion, beginning at the Bay Bridge, is due to reduced lane capacity on the Bay Bridge relative to the approach lanes, and weave/merge movements associated with the toll plaza.

These two queues are often perceived as one continuous delay. It is anticipated that future traffic volumes could increase to the point where the queues begin to encroach upon one another. On a typical summer Friday or Saturday, traffic delays exist over a six-hour period and travel times associated with these delays are increasing. These undesirable operating conditions are expected to worsen significantly, upwards of 12 hours per summer weekend day by 2025. Likewise, travel time delays in this 16-mile segment of approach roadway will deteriorate in much the same fashion in the coming years. By 2025, these types of delays will begin to occur during peak weekday periods, as well. This level of congestion is difficult for bridge drivers, causes increased accidents, and can severely impact access to nearby communities.

Beyond the Transportation Needs Reports: Ongoing and Next Steps in the Process

To begin to understand the diverse and complex issues associated with addressing the transportation needs, the Authority is collecting data and information about the environment and transportation system in the corridor. This information will serve as a starting point for more detailed future engineering and environmental studies of a Bay crossing. As part of this data collection effort, the Authority:

- has reviewed several historic Bay Bridge documents to learn about what crossings have been studied in the past and to determine if any are still applicable today;
- is compiling an inventory of roadway planning, design, and construction projects as well as a review of area comprehensive plans, to understand and document the features of the existing and future transportation system; and
- is identifying and documenting resources in the Study area by inventorying socioeconomic, cultural, and natural environmental features in the study area.

The Authority is also evaluating the legal and process issues that could affect the direction, scope, and constraints of a study of feasible solutions.

In addition, to complete the assessment, an understanding of the needs in the US 50/301 corridor, of which the bridge is an integral part, is also required. Assessments of other systems affected by crossings of the Chesapeake Bay could be or have been undertaken by MDOT, the Maryland Department of Planning (MDP), Maryland Department of the Environment (MDE) and other agencies over the course of several years. These additional studies should contribute to an understanding of the needs across the corridor in the context of statewide and regional plans, such as congestion management recommendations; transit opportunities; development and growth control measures; impacts to natural, cultural, and socio-economic resources; and opportunities for economic growth. Once identified, the needs of the entire system could be addressed in concert, through a statewide effort.

The Bay Bridge Transportation Needs Report represents the first step in identifying the needs, understanding the feasibility of addressing the needs, and developing feasible solutions for a unique and complicated project within the framework of the regulatory and legislative process. The Authority will begin to address these needs through a Feasibility Review. The Feasibility Review will include a Task Force on Traffic Capacity Across the Chesapeake Bay, consisting of representatives from the Chesapeake Bay region and other parts of the State. The purpose of the Task Force is to assist the Authority in evaluating the need for additional capacity, and identifying issues to be considered in addressing those needs. The Feasibility Review will serve as a transition between the Needs Report and future project planning studies.

The Feasibility Review will be a significant undertaking for the State of Maryland. A study of this magnitude and complexity requires a partnership between elected officials, state and federal agencies, and the public within Maryland and beyond state lines. Therefore, the Authority is presenting and will continue to present a variety of future action proposals to the Maryland Department of Transportation for consideration and action.

1

PURPOSE OF STUDY

There are several areas of recurring congestion along US 50 including portions of the roadway near Annapolis, the Severn River, the Chesapeake Bay, and the Eastern Shore. The William Preston Lane Jr. Memorial (Bay) Bridge represents an integral part of the US 50 corridor.

The Maryland Transportation Authority (Authority) is responsible for constructing, managing, operating, and improving the State's toll facilities including the Bay Bridge. As part of the ongoing mission to provide Maryland's citizens and visitors with safe and convenient transportation facilities, the Authority conducted an assessment of the existing and future transportation needs at the Bay Bridge.

To assess the future transportation needs, a full understanding of travel patterns, existing geometric features, and operating conditions was required. Therefore, this study included extensive data collection and analysis. This report documents the results of the data collection effort and analysis of existing (2001) conditions and future transportation needs at the Bay Bridge.

The needs assessment included in this report focuses on one part of the problem: what are the needs associated with the Bay Bridge. However, to fully understand the overall transportation needs in the corridor, a broader analysis of the approach roadways should be conducted. Therefore this transportation needs study represents the first step in a much larger process: identifying the needs, understanding the feasibility of addressing the needs, and developing feasible solutions for a much larger transportation corridor. The needs and recommendations identified in this report will serve as the basis for future studies of the Bay Bridge and the overall US 50 corridor.

The study was completed under the sponsorship of the Authority. At key milestones representatives from the Maryland Department of Transportation (MDOT), Maryland State Highway Administration (MSHA), Baltimore Metropolitan Council (BMC), Delaware Department of Transportation (DelDOT), Washington Metropolitan Council of Governments (MWCOG), and the Authority reviewed and approved the travel demand process and projections. Each of these agencies proved to be valuable resources of information and provided input and review of the traffic and socio-economic information. The responsive participation was appreciated and team members are acknowledged in **Appendix A**.

Figure 1 shows the location of the Bay Bridge; along with the area included in the travel demand model developed for the study. The remainder of this report includes discussions on the existing conditions, future conditions, and conclusions.

Figure 1. Study Area

2

EXISTING CONDITIONS

2.1 Study Area

The study area extends a distance of 5.8 miles along U.S. Route 50/301, between the Oceanic Drive overpass in Anne Arundel County and the MD 8 overpass in Queen Anne's County. Within the study limits, U.S. Route 50/301 includes two parallel steel bridge structures, collectively known as the Bay Bridge, that span 4.3 miles, from shore to shore, across the Chesapeake Bay. The Bay Bridge provides a direct travel link between the metropolitan areas of Baltimore, Washington D.C., and Annapolis and Maryland's Eastern Shore communities. It is the only roadway crossing of the Chesapeake Bay in Maryland. The only surface transportation options to this crossing are to travel around the Bay to the north, through Delaware, or to travel south through Virginia's tidewater area via the Chesapeake Bay Bridge-Tunnel.

2.1.1 History

Prior to construction of the Bay Bridge, the primary method of automobile travel across the Chesapeake Bay was by ferry service, which took approximately two hours. In 1938, legislation authorizing the crossing came from mounting pressure for a bridge, but the effort was postponed due to the onset of World War II. Under the leadership of Governor William Preston Lane, Jr., and the 1947 General Assembly, the Maryland State Roads Commission was directed to proceed with building the Bay Bridge. A growing State highway network, the need to provide safe navigation for ships, and the need to provide improved access to the lower Eastern Shore made a bridge location in the Sandy Point-Matapeake area (near Stevensville) the most desirable, as opposed to earlier efforts that planned for a bridge crossing in the Bay Shore-Tolchester area.

Construction of the world's longest continuous over-water steel bridge at that time began in January 1949, and it was opened to traffic on July 30, 1952. The bridge was designed as a two-lane structure originally meant to carry one lane of traffic in each direction. By the early 1960's, the traffic volume on the bridge had reached its capacity. Consequently, in May 1968, a permit was granted for construction of a new parallel structure located 450 feet north of the existing bridge. Construction on the second bridge began in May 1969, and it was opened to traffic on June 28, 1973. The second bridge, a three-lane structure, is open to westbound travel while the original two-lane bridge carries eastbound traffic, except during contra-flow[1] operations.

The annual traffic on the Bay Bridge in 1952 (when the first bridge was originally opened to traffic) was 1.1 million vehicles. In 2001, the annual number of vehicles crossing the Chesapeake Bay on the Bay Bridge was documented at over 23.9 million vehicles.

2.1.2 Demographics of Areas Near the Bridge

Information presented on population and income is derived from 2000 US Census data, historical census data, and Maryland Department of Planning (MDP) projections.

The City of Baltimore, the largest city in the State of Maryland with a total population of 651,154 in 2000, is located approximately 23 miles northwest of the study area. Washington D.C. is located 28 miles west of the study area along U.S. Route 50/301, with a total population of 525,059 in 2000.

The population in Anne Arundel County grew 14.6 percent from 427,239 people in 1990 to 491,383 people in 2000. This is slightly higher than the growth rate for the Washington region and significantly higher than the growth rate for the Baltimore region for the same period. However, growth rates have declined consistently over the past three decades from 24.4 percent in the 1970s. Maryland's State capital is located in Annapolis, which is the largest city in Anne Arundel County. Annapolis had a recorded population of 35,838 in 2000.

The population in Queen Anne's County grew 19.5 percent from 33,953 people in 1990 to 41,456 people in 2000. While still significant, the population growth rate for Queen Anne's County has also declined consistently from a high of 38.5 percent in the 1970s.

The Eastern Shore community of Stevensville is located within the study area just east of the Bay Bridge in Queen Anne's County. It recorded a total population of 5,880 in year 2000. Several retail outlets located in Stevensville contributed the highest amount in total sales, reported at over $321 million, for Queens Anne's County in 1997.

Population in the upper Eastern Shore counties of Caroline, Cecil, Kent, Queen Anne's and Talbot grew 15.8 percent from 180,726 people in 1990 to 209,295 people in 2000. Similarly, population in the lower Eastern Shore counties of Dorchester, Somerset, Wicomico, and Worcester grew 14.5 percent from 163,043 people in 1990 to 186,608 people in 2000.

In 2000, there were approximately 297,000 jobs in Anne Arundel County. This was an 18.0 percent increase over the 251,600 jobs in 1990. Queen Anne's County job growth peaked in the 1980s with 52.4 percent growth and although it is on a downward trend, job growth rates remain high. In 2000, there were approximately 17,300 jobs in Queen Anne's County. This represents a 34.17 percent increase over the 12,900 jobs in 1990.

Similar job growth occurred in the 1980s in the upper Eastern Shore and lower Eastern Shore counties. Job growth between 1990 and 2000 was 23.5 percent (from 81,200 jobs to 100,300 jobs) for the upper Eastern Shore and 13.4 percent (from 97,600 jobs to 110,700 jobs) for the lower Eastern Shore.

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[1] A contraflow lane is a lane operating in a direction opposite to the normal flow of traffic.

2.1.3 Parallel Routes

The Bay Bridge crosses the Chesapeake Bay linking Central Maryland to the Eastern Shore. It also provides an alternative north-south route for traffic traveling along the east coast. I-95 is located approximately 30 miles west of the Bay Bridge and U.S. Route 13 is located approximately 50 miles to the east. In Maryland, I-95 extends through Central Maryland to the northeastern border of Maryland continuing into Delaware. U.S. Route 13 links the eastern peninsula of Maryland and Virginia at the mouth of the Chesapeake Bay and continues north through Maryland's Eastern Shore into Delaware. Long distance motorists use U.S. Route 50/301 as an alternative to these north-south routes.

2.1.4 Priority Funding Areas

The Maryland Economic Growth, Resource Protection and Planning Act of 1992 (the Planning Act) and the subsequent Smart Growth Priority Funding Areas Act of 1997 direct State and local governments to target their infrastructure investments to designated priority funding areas (PFAs). PFAs are existing communities and places designated by local governments and certified by the Maryland Department of Planning (MDP) as future growth areas where State infrastructure investments should be focused. **Appendix B** includes mapping of the PFAs for the two counties adjacent to the Bay Bridge, Anne Arundel and Queen Anne's counties. On the west side of the Bay Bridge, in Anne Arundel County, the City of Annapolis and the community of Arnold are designated as PFAs. The PFA designations for Queen Anne's County include portions of Kent Island, Stevensville, and Grasonville. The Bay Bridge serves as a critical link in connecting these PFAs on either side of the Chesapeake Bay.

In October 2003, the Priority Places Strategy Executive Order was established. The Priority Places Strategy builds on three decades of State and local land use policy promoting sustainable development and maintaining Maryland's high quality of life. It directs every State agency to work within a deliberate strategy to implement PFAs and planned growth in order to develop long-term solutions to the complicated issues of economic growth, community revitalization, and resource conservation to achieve the best "public return" on State investments.

2.2 Roadway Geometry

The Bay Bridge study area is divided into three distinct segments known as the (1) west approach, (2) bridge structure, and (3) east approach. The following describes the geometric configuration of each segment. Additional geometric elements are recorded in **Table 1** and aerial views of the approach sections are included in **Appendix C**.

2.2.1 West Approach Roadway

The limits of the west approach roadway segment begin at the Oceanic Drive overpass and terminate at the west abutment of the bridge for a total distance of 0.7 mile. U.S. Route 50/301 is a six-lane divided highway as it approaches the Bay Bridge. It is classified as an Urban Principal Arterial and has a posted speed of 50 mph. The three eastbound and westbound through-lanes are 12 feet wide with ten-foot outside shoulders. The inside shoulder varies in width from four to ten feet. There is a 70-foot

Table 1. Roadway Geometry

SEGMENTS	West Approach		Bridge Structure		East Approach	
LIMITS	Oceanic Drive Overpass to West Abutment		West Abutment to East Abutment		East Abutment to MD 8 Overpass	
DIRECTION	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
Roadway Classification	Urban Principal Arterial		Urban Principal Arterial (AA) Rural Principal Arterial (QA)		Rural Principal Arterial	
Posted Speed	50 mph		50 mph		55 mph (eastbound) 50 mph (westbound)	
Number of Lanes	3	3	*2	*3	3	3
Number of Toll Lanes	11	None	None	None	None	None
Lane Width	12’	12’	12’ 5”	12’	12’	12’
Shoulder Width/ Offset	10’ - outside 4 - 10’ - inside (varies)	10’ - outside 4 - 10’ - inside (varies)	1’ 7”	1’	10’ - outside 4 - 8’ – inside (varies)	10’ - outside 4 - 8’ – inside (varies)
Median Width	2’ - 70’ (varies)		None		47’ (varies)	
Maximum Vertical Grade	+1.0%	-1.0%	+/- 3.0%	+/- 3.0%	-0.3%	+0.3%
Reversible Lanes	None		1	1	None	
Transition Length (Leaving Plaza)	600’	None	None		None	

Measurements were taken from existing roadway plans, aerial surveys and drawings provided by the Authority.

* Standard Lane Configuration, AA – Anne Arundel County, QA – Queen Anne’s County

grass median near Oceanic Drive that narrows to a two-foot concrete median barrier approaching the toll plaza.

The eastbound travel way widens from three lanes to an eleven-lane, 192-foot wide toll plaza. East of the plaza, a 600-foot long transition area is provided for traffic to merge back together as it approaches the two-lane eastbound bridge. A wide transition area between the toll plaza and the westbound bridge allows flexibility for contraflow lane operations. The transition area allows for two-way traffic on either bridge. This is primarily used to accommodate bridge maintenance operations and ease congestion in the eastbound direction during peak periods. The transition and lane shift designs meet minimum AASHTO 50 mph design speed standards and allow for a smooth transition of traffic to/from either bridge. **Figure 2** shows a schematic of the west approach roadway geometry in the transition area surrounding the toll plaza. The vertical grade is relatively flat at the toll plaza and increases to one percent at the Bridge.

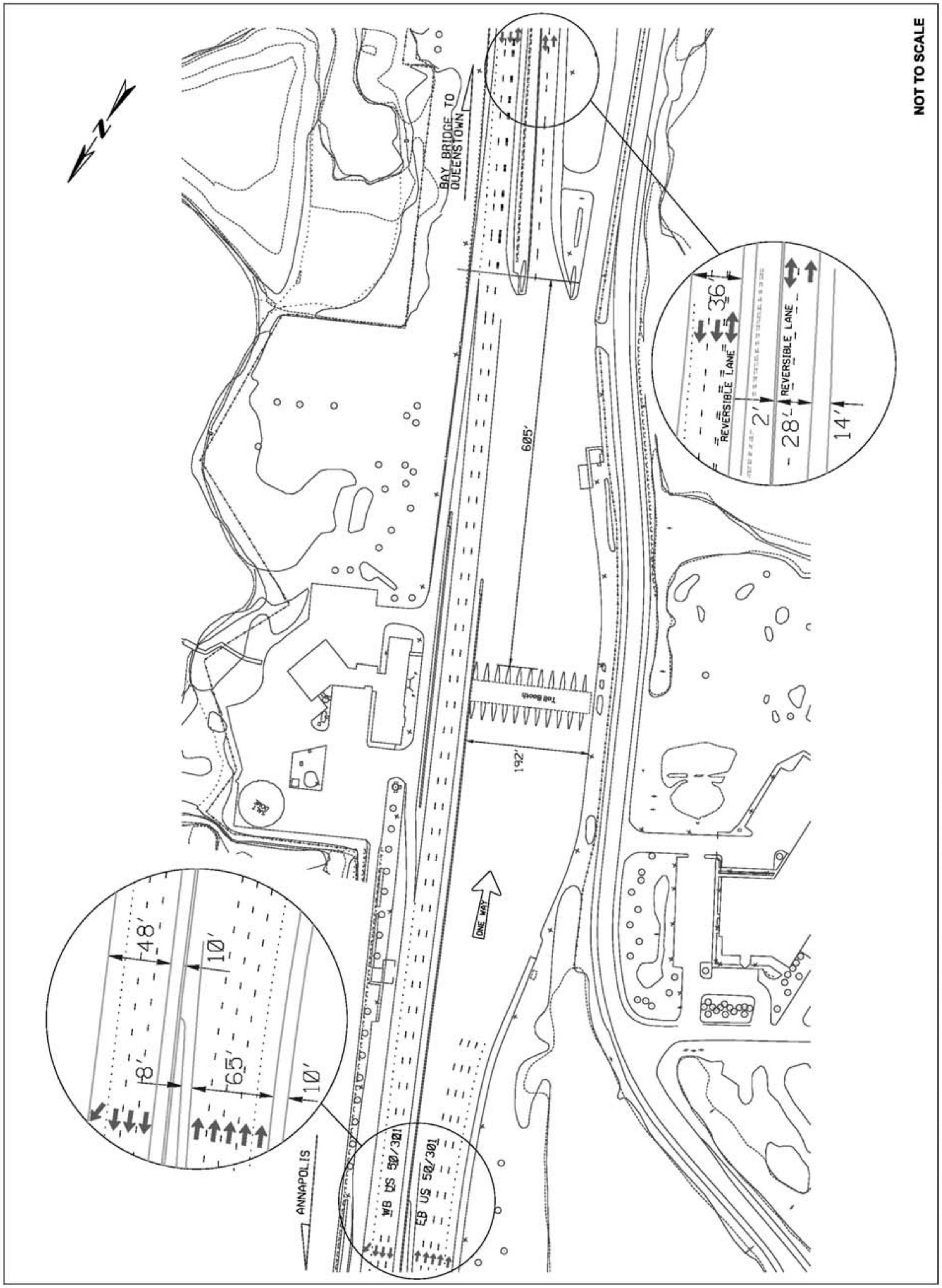


Figure 2. Roadway Geometry Schematic - West Approach

The Authority is currently designing and implementing improvements on the west approach roadway. An extended dedicated travel lane for EZPass vehicles is being added to the median side of the roadway and the overall approach roadway is being widened to provide additional space for vehicles entering the toll plaza. A second project is scheduled to be complete by Summer 2005, which will make similar improvements between the toll plaza and the bridge. Improvements include widening the roadway to allow more space for merging traffic prior to the bridge, and relocating the truck inspection area,

2.2.2 Bridge Structure

A distance of 450 feet separates the eastbound and westbound bridges. Each bridge consists of a partially suspended structure above the Chesapeake Bay, rising to a total height of 354 feet in the eastbound direction and 379 feet in the westbound direction. The roadway height reaches approximately 198 feet above the water. Each bridge measures 4.3 miles shore-to-shore and 4.0 miles abutment-to-abutment. Through this segment the roadway classification changes from an Urban Principal Arterial in Anne Arundel County to a Rural Principal Arterial in Queen Anne's County.

The eastbound bridge carries two lanes of traffic and the westbound bridge carries three lanes of traffic. The eastbound bridge consists of two 12'5" lanes with 1'7" offsets to the bridge rail. The westbound bridge consists of three 12-foot lanes with one-foot offsets to the bridge rails. Both the westbound and eastbound bridges include flexible lane control markings to allow for contraflow operations during maintenance, incident management or periods of congestion. While the bridge lanes are full-width, motorists traveling over bridges often perceive the lanes to be narrower due to the lack of shoulders and presence of railings. This perceived constraint on the roadway can result in lower operational capacity for the lanes on the bridge in comparison to the lanes on the approach roadways. **Figure 3** shows a schematic of the eastbound and westbound bridge lane configurations.

The eastbound bridge follows a southeasterly alignment going on a tangent, or straight line, for a distance of approximately 3,000 feet. It then curves to the east with a 1.67-degree curve and continues straight for approximately 15,800 feet. Along the eastbound bridge, the vertical grades vary in the order of 0.5 to 3.0 percent on the uphill portion to -1.9 to -3.0 percent on the downhill portion. The westbound bridge follows a parallel alignment to the eastbound bridge and has similar vertical grades.

Bridge and roadway plans were reviewed and analyzed to determine if the existing horizontal alignments and vertical grades were appropriate based on current traffic volumes, speed, and design standards. The three percent grade on the eastbound and westbound bridges is within desirable American Association of State Highway and Transportation Officials (AASHTO) guidelines for urban and rural arterials. The steepness of the grade in combination with a stop condition for traffic passing through the eastbound toll plaza, however, results in heavy vehicles traveling below the posted speed on the upgrade causing some delay for all vehicles using the eastbound bridge. The lack of a climbing lane for trucks, which make up more of the vehicle composition than on similar types of facilities, reduces the vehicular capacity of the bridge.

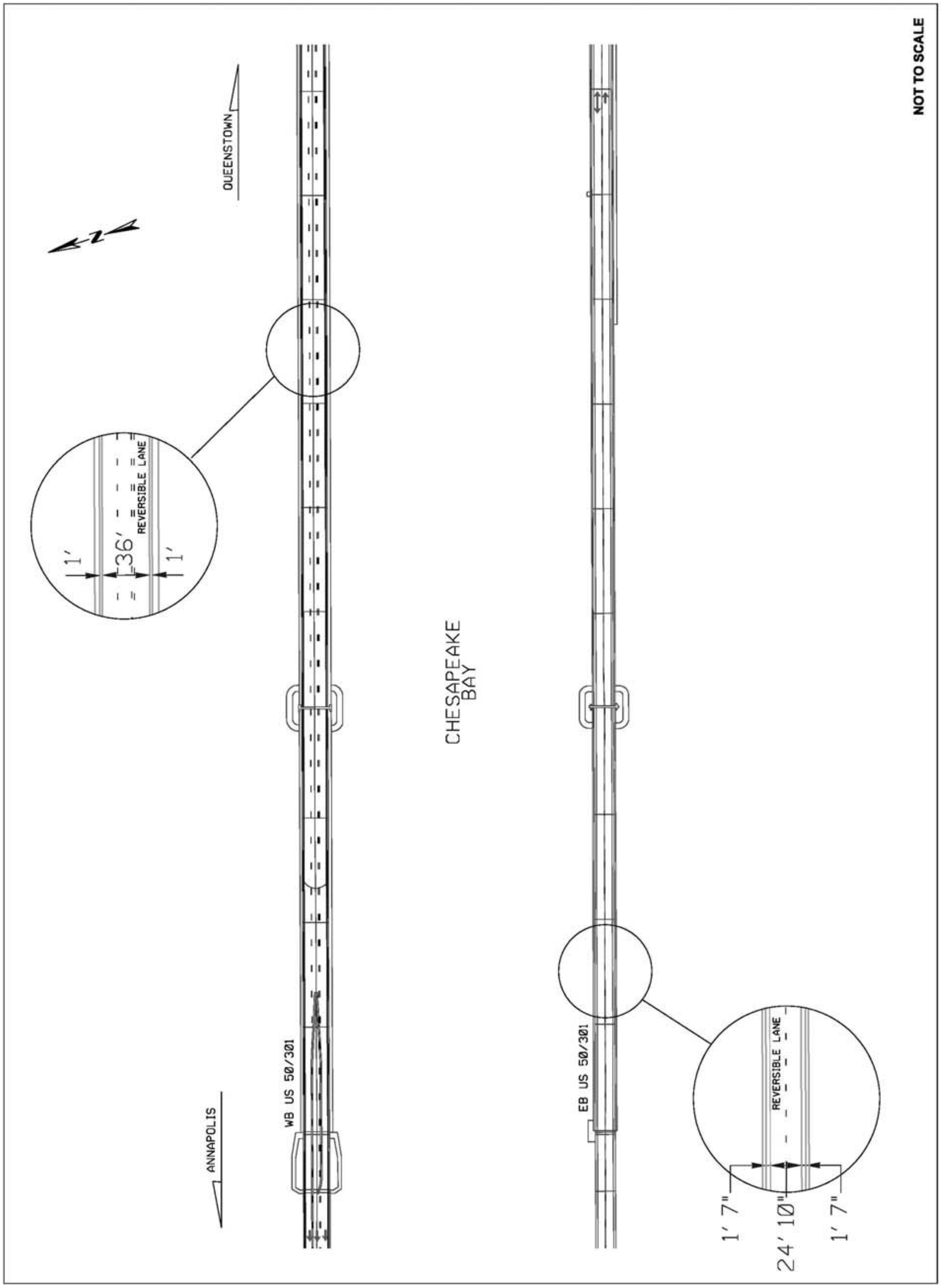


Figure 3. Roadway Geometry Schematic - Bridge Structure

AASHTO recognizes that long span bridges are expensive to construct and maintain, guidelines therefore allow minimal one to two-foot offsets to the bridge railings. Both bridges have minimal offsets; leaving no space for disabled vehicles to safely pull off the traveled lanes. Disabled vehicles subsequently block traffic until towed from the Bridge. The loss of a lane for a disabled vehicle or other incident management activities can have a significant impact on the vehicular capacity of the bridges.

An analysis was conducted to determine if there was sufficient sight distance for drivers to view obstacles or stopped vehicles in the travel lanes. The analysis focused on the crest profile along the top of the bridge and the bridge's vertical geometry was determined to be sufficient. A second review of the horizontal stopping sight distance for the curved sections along each bridge was conducted. The sight lines for bridges on a curve can be limiting when minimal shoulder widths result in the inside rail blocking the drivers ability to see an object or slowing vehicle in the travel lane ahead. For 50 mph (the posted speed on the bridge), AASHTO criteria calls for a minimum stopping sight distance of 400 feet. The existing stopping sight distance on the bridge was computed at 520 feet, exceeding the criteria for 50 mph. In fact, it exceeds the criteria of 495 feet for a design speed of 55 mph.

2.2.3 East Approach Roadway

The east approach measures 1.1 miles between the east abutment and the MD 8 overpass. It includes a six-lane divided highway consisting of three 12-foot lanes in the eastbound and westbound directions separated by a variable-width median, typically approximately 47 feet. It is classified as a Rural Principal Arterial and the posted speed is 55 mph in the eastbound direction and 50 mph in the westbound direction approaching the bridge. The eastbound and westbound roadways include ten-foot outside shoulders. The inside shoulders vary from four to eight feet. The vertical grade approaching the bridge is relatively flat and allows for a smooth multi-directional crossover between the eastbound and westbound roadways.

Figure 4 shows a schematic of the east approach roadway segment in the area adjacent to the bridge. The median crossover is approximately 0.41 miles east of the bridge to accommodate the reversible lanes on both bridges. The crossovers consist of a 26-foot lane in each direction for high-speed transition of vehicles between the bridges and approach roadways. At the times when one lane of the westbound bridge is used for eastbound traffic, westbound traffic approaching the bridge must merge from the three approach lanes to the two lanes in operation on the bridge. Eastbound traffic using the westbound bridge reversible lane has a smooth transition into the third inside lane of eastbound U.S. Route 50/301. From a traffic operations standpoint the eastbound median crossover functions very effectively.

2.3 Travel Patterns

An origin-destination (O-D) survey was conducted in 2001 to determine travel patterns across the Bay Bridge. Separate surveys were conducted in the eastbound direction on a summer weekend day (Saturday in August) and an "average" weekday (Wednesday in October) to capture seasonal variations in traffic crossing the Bridge. The summary of findings of the O-D study is documented in a separate report entitled *"Origin-Destination Survey Report, Bay & Nice Bridge Study, June 5, 2002."* The Origin-Destination travel patterns, trip purpose, vehicle occupancy, vehicle type and willingness of drivers to

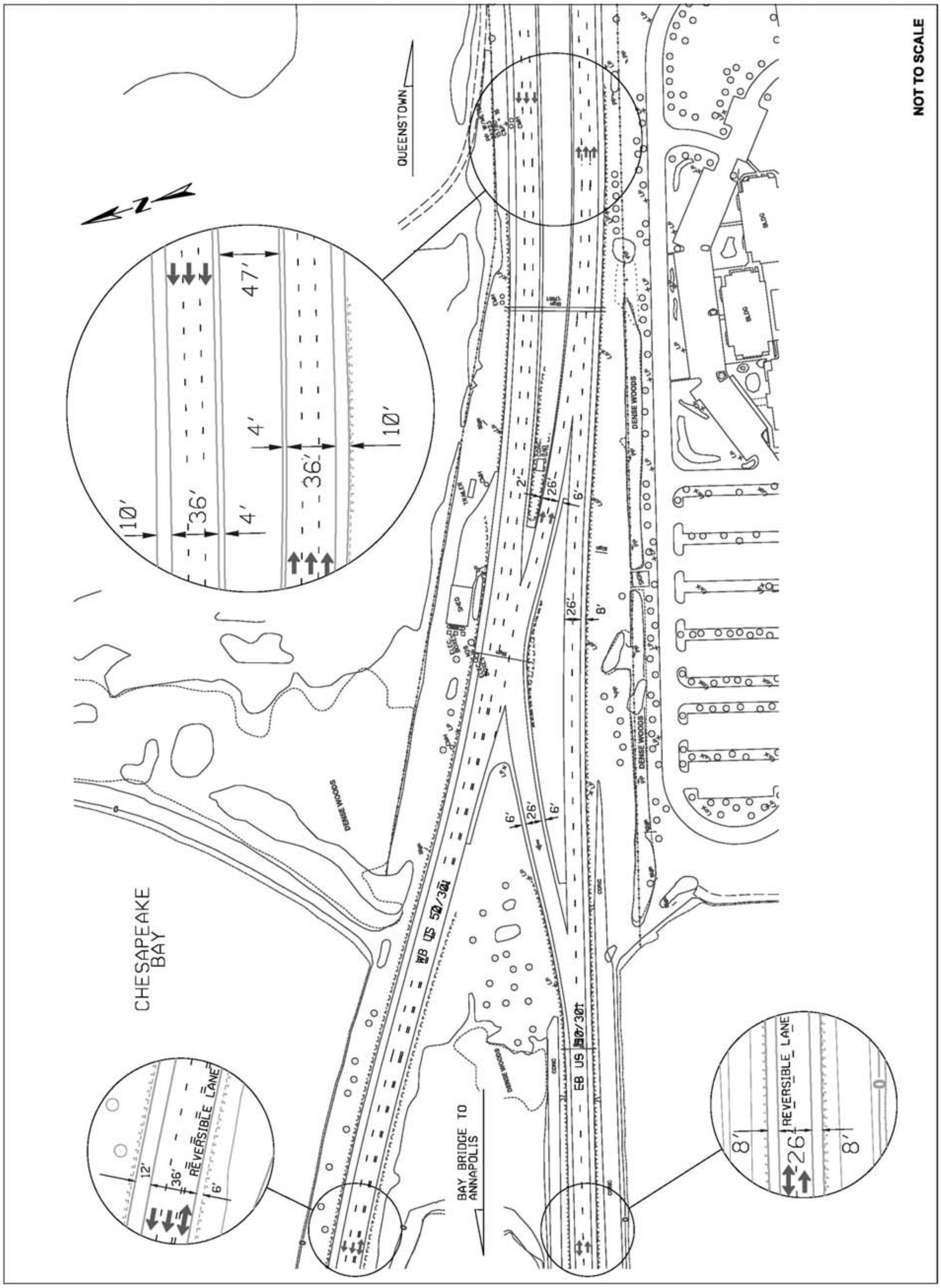


Figure 4. Roadway Geometry Schematic - East Approach

change travel times are summarized in **Figures 5 and 6** for a Saturday during the summer and average weekday, respectively. Of the 53,628 surveys distributed at the Bay Bridge, 18 and 26 percent of the forms were returned for the summer Saturday and average weekday, respectively. This represents valid return rates that provided sufficient data, adequate sample size, and information on both summer weekend and average weekday travel.

As shown on **Figure 5**, on an average Saturday in the summer, 82 percent of the eastbound traffic using the Bay Bridge comes from the Baltimore-Washington metropolitan area. Twenty-four percent of the traffic is destined to Queen Anne's and Kent counties with another 24 percent destined to other locations on Maryland's Eastern Shore, excluding Ocean City. Ocean City and the Delaware Beach resorts attract 23 percent and 20 percent of the traffic, respectively. During the summer Saturday, 83 percent of the trips begin at home and 37 percent are destined to recreation or tourism activities.

On an average weekday (See **Figure 6**), 93 percent of eastbound traffic is from the Baltimore-Washington metropolitan area. Fifty-two percent of the traffic is destined to Queen Anne's and Kent counties with another 35 percent destined to Maryland's Eastern Shore, including Ocean City. On an average weekday, 85 percent of the trips began at work or home and 77 percent end at work or home.

2.4 Traffic

Automatic Traffic Recorders (ATR) were placed on the east side of the Bay Bridge on all travel lanes. Traffic counts were conducted over the August 17-19, 2001 weekend, representative of a summer weekend, and October 16-17, 2001, representative of average weekdays.

For the purpose of assuring the quality of the machine counts, two other data sets were compared to the output of the counting equipment, including toll plaza axle counts and two-hour manual classification counts. The machine counts and toll counts deviated by less than four percent. The percentage difference between the manual and machine count results was less than three percent. **Appendix D (Volume II)** includes classified counts and detailed hourly summaries for both the summer weekend day and average weekday.

2.4.1 Vehicle Classification

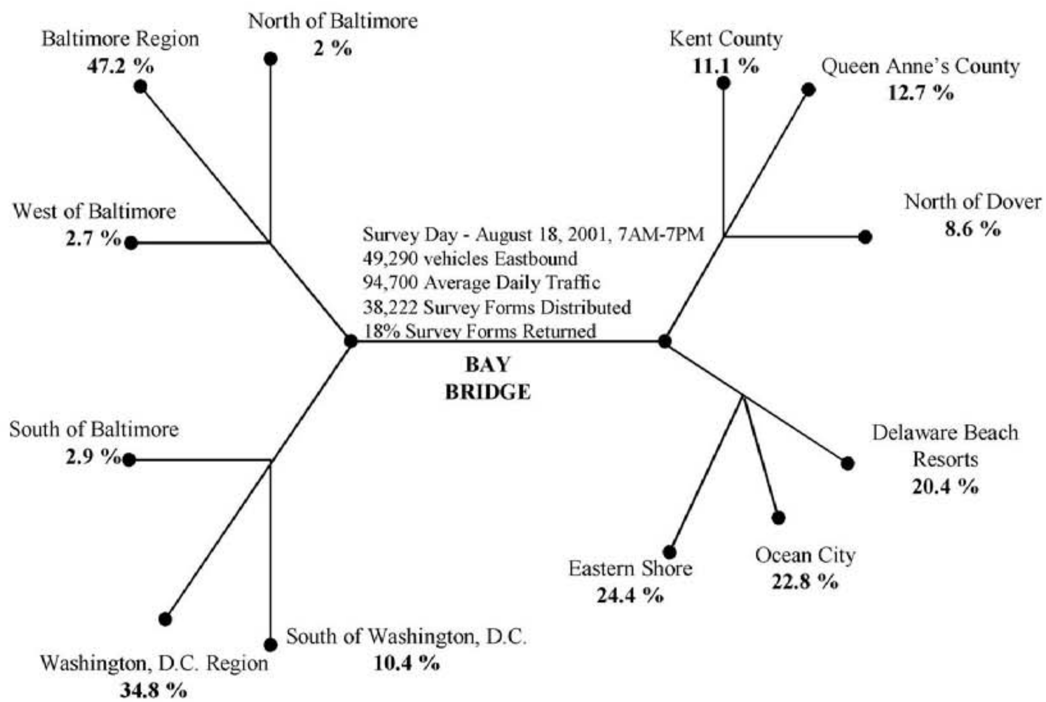
The vehicle classifications recorded on Saturday, August 18, and Wednesday, October 17, are illustrated as percentages in **Table 2**. Heavy vehicles, defined as Single-Unit Trucks and larger, accounted for five percent of total traffic on the August Saturday observation period and 14 percent on the October weekday observation period. The truck percentage of 14 percent for an average weekday significantly exceeds the statewide average of four percent for urban arterials.

Maryland Transportation Authority

William Preston Lane Jr. Memorial Bridge

Existing Summer Weekend Day Travel Patterns

FACT SHEET



1. North of Baltimore includes Cecil County, Pennsylvania and areas to the north.
2. Baltimore Region includes Baltimore City, Baltimore, Harford, Anne Arundel, and Howard counties.
3. West of Baltimore includes Carroll and Frederick counties and areas to the west.
4. South of Baltimore includes Charles, St. Mary's, and Calvert counties.
5. Washington, D.C. Region includes Prince George,s and Montgomery counties.
6. South of Washington, D.C. includes Northern Virginia, Fredericksburg, and areas to south.
7. North of Dover includes central Delaware, Newark and areas north of Newark.
8. Delaware Beach Resorts includes Bethany and Rehoboth.
9. Eastern Shore includes Somerset, Dorchester, Wicomico, Talbot, Caroline and Worcester counties.
10. Real time traffic video available at www.QAC.ORG/PUBINFO/LINKS.HTM and www.CHART.STATE.MD.US/TRAVINFO/TRAFFICCAMS.ASP.

Begin	End	Trips
83 %	24 %	Home
6 %	3 %	Work
3 %	37 %	Recreation/Tourism
2 %	4 %	Shopping
0 %	1 %	School
6 %	31 %	Other

Vehicle Occupancy	
28 %	1 Person
40 %	2 Persons
14 %	3 Persons
13 %	4 Persons
5 %	> 5 Persons

Vehicle Type		
Survey	24-hr. Count (8/18/01)	Vehicle Class
0.1 %	0.2 %	Motorcycles
60.5 %	94 %	Autos
37.7 %		Pick-up/SUV/Minivan
0.7 %		Recreational Vehicle
0.1 %	1.0 %	Bus
0.5 %	2.7 %	Single-unit Trucks
0.4 %	2.6 %	Multi-Unit Trucks

Willingness to change travel time if real time traffic information available	
Yes	57 %
No	43 %

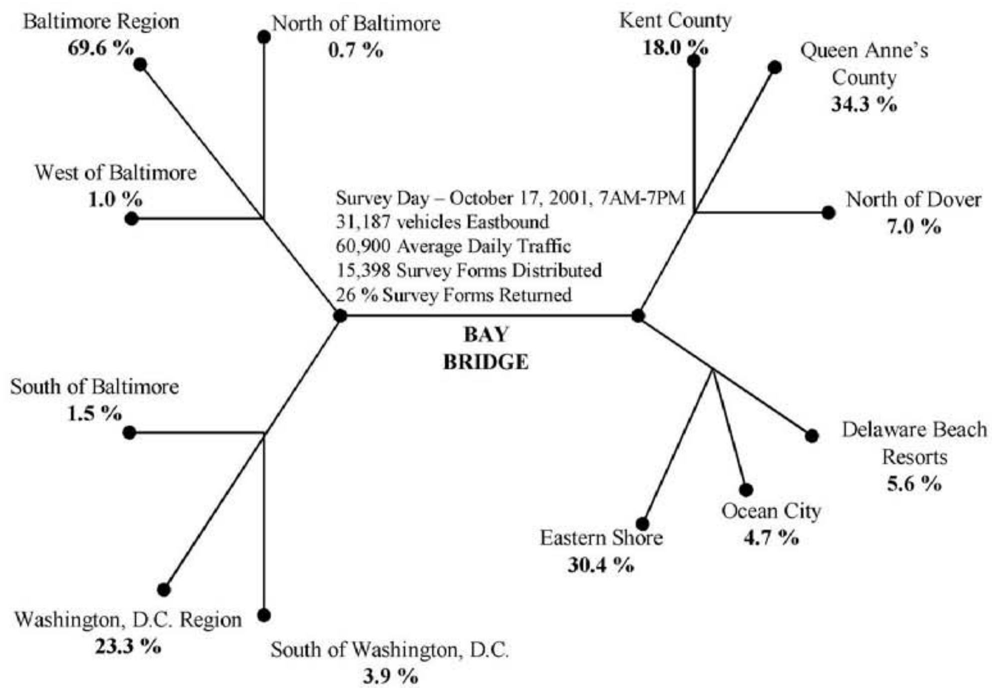
Figure 5. Existing Travel Patterns – Average Summer Weekend Day

Maryland Transportation Authority

William Preston Lane Jr. Memorial Bridge

Existing Average Weekday Travel Patterns

FACT SHEET



1. North of Baltimore includes Cecil County, Pennsylvania and areas to the north.
2. Baltimore Region includes Baltimore City, Baltimore, Harford, Anne Arundel, and Howard counties.
3. West of Baltimore includes Carroll and Frederick counties and areas to the west.
4. South of Baltimore includes Charles, St. Mary's, and Calvert counties.
5. Washington, D.C. Region includes Prince George's and Montgomery counties.
6. South of Washington, D.C. includes Northern Virginia, Fredericksburg, and areas to south.
7. North of Dover includes central Delaware, Newark and areas north of Newark.
8. Delaware Beach Resorts includes Bethany and Rehoboth.
9. Eastern Shore includes Somerset, Dorchester, Wicomico, Talbot, Caroline and Worcester counties.
10. Real time traffic video available at www.QAC.ORG/PUBINFO/LINKS.HTM and www.CHART.STATE.MD.US/TRAVINFO/TRAFFICCAMS.ASP.

Begin	End	Trips
42 %	56 %	Home
43 %	21 %	Work
2 %	8 %	Recreation/Tourism
3 %	3 %	Shopping
2 %	1 %	School
8 %	11 %	Other

Vehicle Occupancy	
72 %	1 Person
22 %	2 Persons
4 %	3 Persons
1.5 %	4 Persons
0.5 %	> 5 Persons

Vehicle Type		
Survey	24-hr Count (10/17/01)	Vehicle Class
0.1 %	0.1 %	Motorcycles
57.2 %	85 %	Autos
38 %		Pick-up/SUV/Minivan
0.6 %		Recreational Vehicle
0.1 %	1.2 %	Bus
1.6 %	4.9 %	Single-unit Trucks
2.4 %	9 %	Multi-Unit Trucks

Willingness to change travel time if real time traffic information available	
Yes	40 %
No	60 %

Figure 6. Existing Travel Patterns – Average Weekday

Table 2. Vehicle Classifications (Percent)

Date	Direction	MC	Cars	Buses	Heavy Vehicles					
					SU	WB40	WB50	WB60	>66'	Total
August 18, 2001 Saturday	**EB**	0.2	93.6	1.0	2.7	0.7	1.3	0.4	0.1	5.2
	WB	0.1	93.4	1.3	2.7	0.8	1.1	0.5	0.1	5.2
October 17, 2001 Wednesday	**EB**	0.1	84.7	1.2	4.9	1.6	5.0	2.3	0.2	14.0
	WB	0.1	85.7	0.9	4.1	1.6	5.6	1.8	0.2	13.3

MC – Motorcycles, SU – Single Unit Trucks, WB – Wheel Base (in feet)
EB – Eastbound, WB – Westbound

2.4.2 Average Daily Traffic

Table 3 summarizes the total daily volumes recorded for the summer weekend. Traffic flow is heaviest on Friday in the eastbound direction (52,594 vehicles) and on Sunday in the westbound direction (53,572 vehicles). This is indicative of the summer weekend travel pattern to destinations along the Eastern Shore of Maryland and Delaware. **Table 4** summarizes total daily traffic volumes recorded for the average weekdays.

Table 3. 2001 Total Daily Traffic Volume

SUMMER WEEKEND			
DATE	**EASTBOUND**	**WESTBOUND**	**TOTAL**
August 17, 2001 Friday	52,594	41,577	94,171
August 18, 2001 Saturday	49,290	45,396	94,686
August 19, 2001 Sunday	33,652	53,572	87,224
Average Annual Daily Traffic			65,000

Table 4. 2001 Total Daily Traffic Volume

AVERAGE WEEKDAY			
DATE	**EASTBOUND**	**WESTBOUND**	**TOTAL**
October 16, 2001 Tuesday	28,741	29,731	58,472
October 17, 2001 Wednesday	31,187	29,714	60,901
Average Annual Daily Traffic			65,000

Detailed hourly summaries are shown in **Appendix D (Volume II)**. Figures D-1 and D-2, in the appendix show 24-hour volumes for both directions over the entire data collection period, including the number of heavy vehicles.

2.4.3 Peak Hour Traffic

Table 5 summarizes peak hour volumes, by direction, for the two observation periods. The highest hourly volume of vehicles for both directions occurred on Friday, between 3:00 PM and 4:00 PM, when a total of 7,055 vehicles were counted.

Table 5. 2001 Directional Peak Hour Summary*

DATE	DIRECTION	PEAK HOUR	PEAK HOUR VOLUME
August 18, 2001 Saturday	Eastbound	9:00 – 10:00 AM 3:00 – 4:00 PM	3,653 3,604
	Westbound	11:00 – 12:00 PM 1:00 – 2:00 PM	2,978 3,585
October 17, 2001 Wednesday	Eastbound	11:00- 12:00 AM 6:00 – 7:00 PM	1,596 3,181
	Westbound	7:00 – 8:00 AM	2,891
		3:00 – 4:00 PM	1,761

*The combined highest hourly volume of vehicles for both directions occurred on Friday, between 3:00 and 4:00 PM.

2.4.4 Capacity Analysis

The mathematical relationships presented in this section are based on the procedures contained within the 2000 Edition of the *Highway Capacity Manual* (Transportation Research Board, 2000), in particular "Chapter 13 – Freeway Concepts." The actual calculations were performed using the input and output mechanisms contained in the latest version of HCS-2000 Highway Capacity Software, Version 4.1b.

The *Highway Capacity Manual* defines Level of Service (LOS) as "*a qualitative measure describing operational conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience*." Six LOS are defined for each type of facility and are designated from A to F, with LOS "A" representing the best operating conditions with free traffic flow and low volumes and LOS "F" representing the worst conditions with low speeds and frequent delays. LOS "F" is considered undesirable. LOS D is approaching unstable traffic conditions with heavy volumes and decreasing speeds. LOS E has high volumes approaching the capacity of the roadway and is characterized with low speeds and delays. **Table 6** summarizes the Bay Bridge LOS results for an average Saturday in summer between 7 AM and 7 PM, under normal operating conditions (two lanes eastbound, three lanes westbound). This analysis was performed for comparison purposes. However, during periods of peak hour congestion, the Authority would move to contraflow operations to address capacity constraints. It is important to note that contraflow operations are a *normal* operating procedure at the Bay Bridge, however, for the purpose of this study normal operating conditions refer to two eastbound lanes and three westbound lanes and contraflow operations refer to three eastbound lanes and two westbound lanes. Capacity analysis worksheets are included in **Appendix E (Volume II)**.

Table 6. 2001 Hourly Level of Service (LOS) - Saturday

SUMMER WEEKEND DAY* - SATURDAY				
START TIME	**2001 EB TOTAL**	**LOS**	**2001 WB TOTAL**	**LOS**
7:00 AM	2,935	D	1,019	A
8:00	3,572	E	1,445	A
9:00	3,653	E	1,887	B
10:00	3,524	D	2,439	B
11:00	3,443	D	2,978	C
12:00 PM	3,508	D	2,695	B
1:00	3,010	D	3,585	C
2:00	3,083	D	3,333	C
3:00	3,604	E	2,565	B
4:00	3,467	D	2,327	B
5:00	1,985	C	3,488	C
6:00	2,201	C	2,931	C

* Hourly volumes from data collected on Saturday, August 18, 2001.

The heaviest observed total traffic volume occurred on Friday, August 17, 2001 between 3 PM and 4 PM. Therefore, a LOS analysis was also conducted for the midday period for Friday and the results are shown in **Table 7**.

Table 7. 2001 Hourly Level of Service (LOS) - Friday

SUMMER WEEKEND DAY** - FRIDAY				
START TIME	**2001 EB TOTAL**	**LOS**	**2001 WB TOTAL**	**LOS**
12:00 PM	3,332	D	2434	B
1:00	3,440	D	2,652	B
2:00	3,804	E	2,627	B
3:00	4,013	F	3,042	C
4:00	3,972	E	2,878	C
5:00	4,011	F	2,563	B
6:00	3,146	D	2,435	B

** Hourly volumes from data collected on Friday, August 17, 2001.

Table 8 summarizes the Bay Bridge Level of Service (LOS) results between 7 AM and 7 PM for an average weekday under normal operating conditions (two lanes eastbound, three lanes westbound).

Table 8. 2001 Level of Service (LOS) – Average Weekday

AVERAGE WEEKDAY*				
START TIME	**2001 EB TOTAL**	**LOS**	**2001 WB TOTAL**	**LOS**
7:00 AM	1,221	B	2,891	C
8:00	1,405	B	2,505	B
9:00	1,282	B	1,781	B
10:00	1,370	B	1,571	A
11:00	1,596	B	1,505	A
12:00 PM	1,544	B	1,449	A
1:00	1,752	B	1,613	A
2:00	1,792	B	1,716	A
3:00	2,185	C	1,761	A
4:00	2,599	C	1,698	A
5:00	3,082	D	1,576	A
6:00	3,181	D	1,329	A

* Hourly volumes from data collected on Wednesday, October 17, 2001.

Contraflow Operation. Contraflow lane operations typically occur during periods of peak traffic volumes or during maintenance, construction or incident management activities. The configuration of contraflow lanes may vary. However, during typical contraflow lane operations the lane usage of one of the lanes on the westbound bridge is reversed to provide a third eastbound lane (See **Figure 7**).

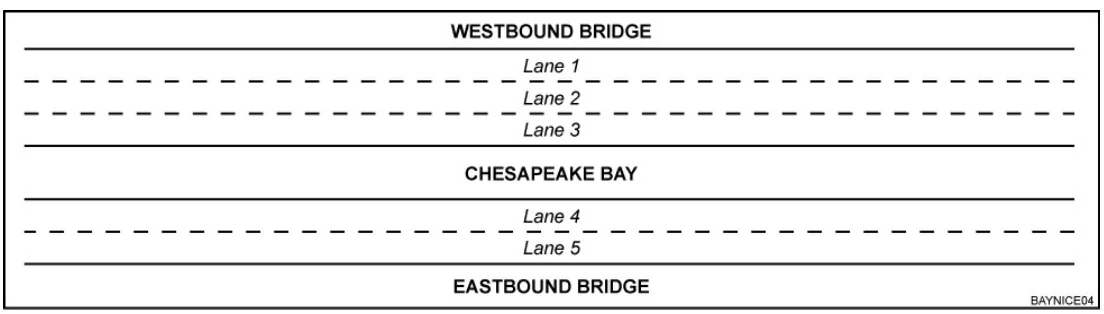


Figure 7. Contraflow Lane Operations

The Highway Capacity Manual does not have a set of procedures to evaluate this type of reversible lane operation. Therefore, to calculate LOS for multi-lane traffic with adjacent opposing traffic, the LOS for westbound traffic was estimated by analyzing the traffic as a two-lane, two-way highway (for the middle lane on the westbound bridge) and a multi-lane highway (for the outside westbound lane). Actual percentage volumes per lane were used for this analysis. Similarly, the eastbound traffic was analyzed as a two-lane, two-way highway for the traffic on the westbound bridge and a two-lane freeway for traffic on the eastbound bridge.

The following analysis focuses on the peak periods identified for the eastbound direction of travel for Saturday in summer. **Table 9** shows the LOS under the contraflow lane operation (three lanes eastbound, two lanes westbound), for the peak flow in the eastbound direction and the corresponding LOS in the westbound direction. For comparison purposes, the table also shows the LOS in each direction under normal (two lanes eastbound, three lanes westbound) operating conditions. The portion of the table highlighted in the boxes indicates the hours when the contraflow operation is likely to be in effect. As shown in the table, westbound congestion occurs as a result of contraflow operation.

Toll Operations. The increased volumes of traffic on summer weekend days cause the section of U.S. Route 50/301 approaching the toll plaza to experience significant congestion queuing. The queues usually start to build on Friday around midday and last into the evening (approximately 6 – 7 PM). Queues during average summer Saturday travel have been measured between two to almost five miles approaching the toll plaza. The queues tend to be longer during summer holiday weekends such as Memorial Day and Independence Day. Motorists are also informed by variable message signs (VMS), traffic advisory radio (TAR), the Authority's website, web cameras, recorded telephone messages and media reports about traffic conditions at the Bay Bridge. During the peak period of eastbound travel, the two-way reversible lane is placed in effect (third eastbound lane on the westbound bridge) and all eleven-toll lanes are opened.

Table 9. 2001 Hourly Level of Service- Contraflow Lane Operations

SUMMER SATURDAY								
	EASTBOUND				WESTBOUND			
START TIME	2001 EB TOTAL TRAFFIC VOLUME	Level of Service: Normal Operations (Lanes 4 & 5)	Level of Service: Contraflow Operations Lanes 4 & 5	Level of Service: Contraflow Operations Lane 3	2001 WB TOTAL TRAFFIC VOLUME	Level of Service: Normal Operations (Lanes 1, 2, & 3)	Level of Service: Contraflow Operations Lane 1	Level of Service: Contraflow Operations Lane 2
7:00 AM	2,935	D	C	E	1,019	A	A	E
8:00	3,572	E	D	E	1,445	A	B	E
9:00	3,653	E	D	E	1,887	B	C	E
10:00	3,524	D	D	E	2,439	B	C	E
11:00	3,443	D	D	E	2,978	C	D	E
12:00 PM	3,508	D	D	E	2,695	B	D	E
1:00	3,010	D	C	F	3,585	C	E	F
2:00	3,083	D	D	F	3,333	C	D	F
3:00	3,604	E	D	E	2,565	B	C	E
4:00	3,467	D	D	E	2,327	B	C	E
5:00	1,985	C	B	F	3,488	C	D	F
6:00	2,201	C	C	E	2,931	C	D	E

Lane numbers correspond to lanes shown in Figure 7.
Note: Areas highlighted by double-lined box indicate hours of likely reversible lane operation.

During the non-summer months, when there are no incidents, maintenance, or construction activities, traffic operates reasonably well at the toll plaza with maximum queues not extending beyond the Oceanic Drive overpass (approximately 1500 feet).

2.5 Accident History

The Maryland State Highway Administration's (SHA) Office of Traffic and Safety (OOTS) provided accident data for the period between January 1999 and October 2002. Data from OOTS included yearly and combined summaries indicating the location (log mile), type and severity of accidents; number and types of vehicles involved in the accident; weather and surface conditions; time of day; and a comparison of study area rates to Statewide average rates for similarly classified State maintained highways or composite sections. For the analysis of accidents on the Bay Bridge, accident rates in Anne Arundel County were compared to other Urban Principal Arterials and accident rates in Queen Anne's County were compared to Rural Principal Arterials to be consistent with the classification of the roadway in each segment. The State Highway Location Reference Manual was used to categorize accidents into roadway segments by matching mile point descriptions with the appropriate log mile. Accident statistics were quantified and summarized by the five principal elements on the following list.

- Accident Occurrence (total number, collision type and rate)
- Accident Severity (number of deaths and/or injuries occurring)
- Accident Involvements (categories of vehicles involved)
- Accident Location (roadway and bridge segments)
- Time of day and year

Accident statistics were analyzed for the overall study area as well as the individual segments to determine any relevant trends. It should be noted that accident locations on police reports are sometimes listed by the nearest land mark which may result in the "clumping" of accident locations by mile point. Detailed accident summaries are included in **Appendix F (Volume II)**.

2.5.1 Overall Study Area

Accident data provided by OOTS showed a total of 402 accidents on U.S. Route 50/301 between the Oceanic Drive overpass in Anne Arundel County and the MD 8 overpass in Queen Anne's County (total length of 5.78 miles). This includes 94 accidents in 1999, 92 in 2000, 105 in 2001, and 111 in the first ten months of 2002.

There were 291 accidents in Anne Arundel County and 111 accidents in Queen Anne's County. This results in accident rates of 102.6 and 37.6 accidents per 100 million vehicles miles of travel (VMT) for Anne Arundel and Queen Anne's counties, respectively. The rate in Anne Arundel County is significantly higher than the statewide average rate of 54.7 for similarly classified State maintained highways or composite sections, in this case other urban principal arterials. It should be noted, however, that most other urban principal arterials in Maryland do not contain toll plazas. The rate in Queen Anne's County is below the statewide rate of 38.5 for similar rural principal arterials.

The total accidents, by severity, are shown in **Table 10**. For the analysis period, three accidents (less than one percent) involved fatalities. The corresponding fatal accident rates equal/just exceed the corresponding statewide rates for similarly classified urban and rural facilities. The total number of accidents involving injury and property damage result in corresponding accident rates in Queen Anne's County that are below the statewide rates for similar rural facilities. However, the accident rates for injury and property damage accidents, as well as the total number of accidents, in Anne Arundel County significantly exceed the statewide rates for similarly classified urban facilities. As stated previously, most other urban principal arterials in Maryland do not contain toll plazas with the associated merging. In addition, traffic through the toll plaza tends travel at slower speeds lowering the severity of the accidents. This results in more property damage accidents and fewer personal injury accidents.

Table 10. Overall Study Area Accidents by Severity

Accident Severity	Number of Accidents			Study Rate*		Statewide Rate*	
	AA	QA	Total	AA	QA	Urban	Rural
Fatal Accidents	1	2	3	0.4	0.7	0.4	0.5
Injury Accidents	101	44	145	35.6	14.9	21.5	15.2
Property Damage Accidents	189	65	254	66.6	22.0	32.8	22.7
Total Accidents	291	111	402	102.6	37.6	54.7	38.5

* Accident rates are calculated as the number of accidents per 100 million vehicle miles of travel.

As shown in **Table 11**, the most prevalent accident type was identified as rear-end collisions which are frequently associated with traffic congestion. Rear-end collisions account for 60 percent, or a total of 242 accidents, during the analysis period. This results in a rear-end accident rate that is significantly higher than the Statewide rates for similarly classified urban and rural facilities. In Anne Arundel County other types of accidents significantly exceeding statewide rates for similarly classified urban facilities include fixed object, opposite direction, and other collisions. In Queen Anne's County other types of accidents significantly exceeding statewide rates for similar rural facilities include accidents involving parked vehicles and "other" collisions.

Table 11. Overall Study Area Accidents by Type

Accident Type	Number of Accidents			Study Rate*		Statewide Rate*	
	AA	QA	Total	AA	QA	Urban	Rural
Opposite Direction	2	1	3	0.7	0.0	0.3	0.3
Rear End	172	70	242	60.6	23.7	21.5	8.9
Sideswipe	11	8	19	3.9	2.7	7.2	3.6
Angle Collision	2	0	2	0.7	0.0	0.3	0.3
Parked Vehicles	3	4	7	1.0	1.4	1.3	0.7
Fixed Object	58	12	70	20.4	4.0	14.2	14.1
Other	43	16	59	15.2	5.4	4.9	2.2
Total Accidents	291	111	402	102.6	37.6	54.7	38.5
Truck Related	84	24	108	28.4	7.2	9.2	6.7

* Accident rates are calculated as the number of accidents per 100 million vehicle miles of travel.

The majority of accidents occurred in dry weather and in daylight conditions. Fifty-one percent occurred on a Friday, Saturday, or Sunday with 45 percent of them occurring on Fridays. The total daily traffic volume on an average Friday in the summer is approximately 40 percent higher than the average annual daily traffic. Thirty-nine percent of the accidents occurred in the summer months of June, July, or August, which account for approximately 35 percent of the annual Vehicle Miles of Travel (VMT). Of these summer accidents, 60 percent occurred on Friday, Saturday, or Sunday.

Of the total number of accidents, 27 percent (108 accidents) were truck-related accidents The resulting truck accident rate for the Anne Arundel County portion of the study area is significantly higher than the Statewide rate for truck-related accidents on similarly classified urban facilities. This correlates with a higher than average percent of trucks in the study area (five percent for average summer Saturdays and 14 percent for average weekdays).

There were a total of 885 vehicles involved in accidents during the analysis period (many accidents involve more than one vehicle). Trucks accounted for 12 percent of the vehicles involved in accidents. Traffic counts collected in August and October of 2001 show truck percentages of five percent for average summer Saturday and 14 percent for average weekday. This is higher than the statewide average of four percent for other urban principal arterials and may account, in part, for the higher than average truck accident rate.

The primary cause listed on police reports for 53 percent of the total accidents was failure to give full time/attention which may be a result of drivers being distracted by the volume of traffic, geometric conditions, other vehicle occupants, in-vehicle electronic devices, scenery and/or unfamiliar roadways. In addition, eastbound drivers traveling through the toll plaza can be distracted while trying to find money for the toll or putting away change and/or receipts. Other major causes include driving too fast for conditions, following too closely, under the influence of drugs or alcohol, vehicle defects, and unknown or other causes.

2.5.2 Segment Summary

An analysis of the total number of accidents recorded during the analysis period shows 139 accidents (35 percent) occurring along the west approach, 53 accidents (13 percent) occurring along the east approach, and 210 accidents (52 percent) occurring along the bridge structure (See **Table 12**). The number of accidents per mile was computed based on the total number of accidents for each segment divided by the length recorded in miles of the segment. While the majority of accidents occurred along the bridge structure, the highest concentration of accidents occurred at locations along the west approach roadway, primarily in the eastbound direction.

Table 12. Accident Summary by Segment

Segment	Number of Accidents	Percent of Total Accidents	Accidents/Mile
West Approach Roadway	139	35	210.6
Bridge	210	52	51.7
East Approach Roadway	53	13	50.0
Total	402	100	69.6

Accident records indicate that there were a total of 139 accidents on the west approach roadway segment for the analysis period. Thirty-five percent, 48 accidents were listed as occurring at log mile 17.34, the location of the tollbooths. Experience shows that accidents are often reported at the nearest "landmark" and these accidents most likely occurred at and in the general vicinity of the tollbooths. Of the accidents listed at this location, 69 percent (33 accidents) were fixed object collisions which most likely include lane control markers such as traffic cones, variable message signs, the truck inspection area, dividers between the toll lanes, and the tollbooths themselves. The probable cause listed on police reports for 73 percent of these accidents was failure to give full time/attention.

The second highest occurrence of accidents is at log mile 17.71, which represents the beginning of the bridge. Fourteen, 10 percent, of the total accidents on this segment occurred at this location. Of the 14 total accidents at this location, 11 accidents (79 percent) were rear end collisions. The primary causes listed on police reports were failure to give full time/attention, following too closely, and too fast for conditions. There are many factors that could lead to this including differing driver behavior (some drivers may slow when entering the bridge while others speed up), the change in pavement material, and the change in roadway characteristics (entering a constrained segment without shoulders).

Of the 139 total accidents occurring on the west approach roadway, 37 percent were rear end collision, 35 percent were fixed object collisions, and 19 percent were other types of collisions (See **Table 13**). Of the fixed object collisions, 65 percent involved objects identified as "other". Other fixed object accidents involved guardrail/barrier, light poles, buildings, curb, and crash attenuators. The remaining accident types included sideswipe, parked, and angle collisions. Seventy-three of the total accidents on this segment, 53 percent, were due to the driver's failure to give full time/attention. Other causes for accidents included driving too fast for conditions, following too closely, improper lane change, passing, turning, or backing, vehicle defects, under the influence of alcohol, failure to yield the right-of-way, physical/mental difficulty, fell asleep/fainted, animal, icy or snow covered road, and unknown or other causes.

Table 13. Accident Types Occurring on the West Approach Roadway

Accident Type	Number of Accidents	Percent of Total Accidents
Opposite Direction	0	0
Rear End	52	37
Sideswipe	9	7
Angle Collision	1	1
Parked Vehicles	2	1
Fixed Object	48	35
Other	27	19
Total	139	100

The majority of accidents occurred in dry weather and during daylight conditions. Approximately 45 percent occurred on Friday, Saturday, or Sunday. The remaining 55 percent occurred Monday through Thursday. Forty-eight accidents, 35 percent, occurred during the summer months of June, July, and August, which represent 25 percent of the year. Of these summer accidents, 20 accidents, 42 percent, occurred on a Friday, Saturday, or Sunday. This is consistent with the weekend rates seen for the entire year.

As shown in **Table 14**, there were 53 accidents for the analysis period on the east approach roadway. Twenty-one percent, 11 accidents, occurred at log mile 2.95, the end of the study area near the MD 8 overpass and ramps. Twenty-six of the total accidents, 49 percent, were rear end collisions. Other accident types include fixed object, sideswipe, opposite direction, and other accidents. The primary cause listed on police reports for 43 percent of the accidents was failure to give full time/attention. Other causes include following too closely, driving too fast for conditions, driving under the influence of alcohol, animal, wet/icy/snow covered roadways, and unknown or other causes. There were also two instances of improper lane changes and one instance each of a driver falling asleep or fainting, an inoperable traffic control device, and a vehicle defect. Information was not available to determine the number of accidents on the east approach roadway that occurred during contraflow operations when westbound traffic has to merge from three lanes on the approach roadway to two lanes on the bridge.

Table 14. Accident Types Occurring on the East Approach Roadway

Accident Type	Number of Accidents	Percent of Total Accidents
Opposite Direction	1	2
Rear End	26	49
Sideswipe	6	11
Angle Collision	0	0
Parked Vehicles	0	0
Fixed Object	8	15
Other	12	23
Total	53	100

The majority of accidents occurred in dry weather and in daylight conditions. Approximately 58 percent occurred on a Friday, Saturday, or Sunday. The remaining 42 percent occurred Monday through Thursday. Twenty-four accidents, 45 percent, occurred during the summer months of June, July, and August, which represents 25 percent of the year. Of these summer accidents, 71 percent occurred on a Friday, Saturday, or Sunday. This is higher than the weekend rates seen for the rest of the year.

There were a total of 210 accidents on the bridge structure for the analysis period (See **Table 15**). The majority, 78 percent, were rear end collisions. The remaining accidents were fixed object, parked, sideswipe, opposite direction, angle, and other. The primary cause listed on police reports was failure to give full time/attention. Other causes included traveling too fast for conditions and following too closely.

Table 15. Accident Types Occurring on the Bridge Structure

Accident Type	Number of Accidents	Percent of Total Accidents
Opposite Direction	2	1
Rear End	164	78
Sideswipe	4	2
Angle Collision	1	1
Parked Vehicles	5	2
Fixed Object	13	6
Other	21	10
Total	210	100

The majority of accidents occurred in dry weather and during daylight conditions. Approximately 52 percent occurred on Friday, Saturday, or Sunday. The remaining 48 percent occurred on Monday through Thursday. Forty percent occurred during the summer months of June, July, and August. Of these summer accidents, 57 accidents (68 percent) occurred on a Friday, Saturday, or Sunday. The high level of weekend and summer accidents may be a result of vacation and recreational drivers who are less familiar with the bridge and it's setting. These drivers are more likely distracted by the views from the bridge and lack of shoulders.

3

FUTURE CONDITIONS

3.1 Demographics of Areas Near the Bridge

Demographic projections presented in this section are from the Maryland Department of Planning (MDP). These projections are consistent with projections from the Baltimore Metropolitan Council and Metropolitan Washington Council of Governments.

MDP projects that the population of Anne Arundel County will increase 8.7 percent between 2000 and 2010 to approximately 532,200. This is lower than the 11.4 percent growth rate MDP projects for the Washington region but higher than the 5.5 percent growth rate they expect for the Baltimore region. The population of Queen Anne's County is projected to increase 19.6 percent by 2010 to approximately 48,500. This is higher than the projected growth rates for the Baltimore and Washington regions and is the highest of the upper Eastern Shore counties (Caroline, Cecil, Kent, Queen Anne's and Talbot). Population in the upper Eastern Shore counties is projected to grow another 10.8 percent by 2010 to approximately 231,800 people. Similarly, population in the lower Eastern Shore counties (Dorchester, Somerset, Wicomico, and Worcester) is projected to grow an additional 8.2 percent by 2010 to approximately 202,000 people.

Similarly, MDP projects the number of jobs in Anne Arundel County to increase by 11.4 percent between 2000 and 2010 to an approximate 330,900 jobs. This represents a downward trend from the high level of job growth in the 1970s (35.4 percent) and 1980s (43.0 percent). The number of jobs in Queen Anne's County is projected to increase by 20.0 percent by 2010 to an approximate 21,000 jobs. Job growth is projected to continue by 13.4 and 12.2 percent by 2010 for the upper and lower Eastern Shore counties, respectively.

3.2 Bridge Structure

The westbound bridge deck has been undergoing rehabilitation since January 2002. The completion of the work should meet all major reconstruction and maintenance needs on the westbound structure in the foreseeable future.

In general, the deck of the eastbound bridge is in good condition. The concrete deck panels and cast-in-place concrete deck spans exhibit minor cracking. Considering the current condition of the deck and the projected increases in traffic volumes, it is anticipated that the deck will require rehabilitation around 2018. Depending on the type and method of construction, the rehabilitation could require either long-term single lane closures or complete night time bridge closures. Because the bridge is projected to carry significant traffic volumes by 2018, the rehabilitation would likely result in substantial travel time delays.

3.3 Traffic

Unconstrained Average Daily Traffic (ADT) volume projections for 2025 were developed for a Saturday in summer and an average weekday as described in the *Travel Demand Model Technical Memorandum*, 2003. The projections represent unconstrained demand that does not account for congestion on the local roadway network or the maximum allowable throughput of the bridges or tollbooths. The unconstrained ADT forecasts were converted to unconstrained hourly volumes using hourly distribution K-factors[2] developed from existing (2001) count data. A capacity analysis was then performed based on the hourly volumes. This sketch level traffic analysis was deemed most appropriate for a quick assessment of the future transportation needs at the Bay Bridge and is based on the eastbound origin-destination survey and seasonal count data as well as regional transportation and land use models.

3.3.1 Average Daily Traffic

Consistent with the downward demographic trends, growth in Annual Average Daily Traffic (AADT) has declined over the last two decades from 5.4 percent per year between 1980 and 1985 to 3.2 percent per year from 1995 to 2000[3]. Historical traffic data provided by the Authority also indicates an annual increase in summer daily traffic of approximately one percent per year. While the rate of overall annual traffic growth is expected to continue to decrease, summer Average Daily Traffic volumes are forecasted to increase at a slightly higher rate of approximately two percent per year.

Summer Saturday. The projected two-direction unconstrained daily traffic on the Bay Bridge for year 2025 on a Saturday in summer is 135,000 vehicles. This is a 42 percent increase in traffic from year 2001[4] (95,000 vehicles on a Saturday in August). The daily directional split in traffic based on existing count data for a Saturday in summer is 55 percent eastbound and 45 percent westbound.

Average Weekday. The projected two-direction unconstrained daily traffic on the Bay Bridge for year 2025 on an average weekday is 86,000 vehicles. This is a 41 percent increase in traffic from year 2001[5] (61,000 vehicles). The daily directional split in traffic based on existing count data for an average weekday is 50 percent eastbound and 50 percent westbound.

[2] K-Factor – The proportion of Average Daily Traffic (ADT) occurring in the analysis hour. Source: 2000 Highway Capacity Manual, Transportation Research Board.
[3] Data on AADT provided by the Authority.
[4] Traffic counts conducted in August 2001 were used for comparison purposes. Base year for modeling purposes is 2000.
[5] Traffic counts collected in October 2001 used for comparison purposes. Base year for modeling is 2000.

3.3.2 Peak Hour Traffic

Summer Saturday. Hourly distribution of directional traffic for year 2025 was developed based on K-factors derived from 24-hour counts conducted on Saturday, August 18, 2001. The directional K-factors and hourly distribution for 2025 are shown in **Table 16**. This results in unconstrained hourly volumes that are in excess of the capacity of the toll plaza and the bridges. A separate study conducted for the Authority determined the maximum volumes that can be serviced under LOS E conditions for the toll plaza and bridge. Based on that study, the maximum LOS E volume for eastbound traffic on the Bay Bridge, under contraflow conditions, was calculated to be 5,175 vehicles. Volumes exceeding this limit would result in LOS F conditions.

Table 16. 2025 Unconstrained Hourly Volumes

SUMMER SATURDAY					
START TIME	**WEEKEND EB K-FACTOR**	**2025 EB TOTAL**	**WEEKEND WB K-FACTOR**	**2025 WB TOTAL**	**TOTAL**
12:00 AM	1.02%	770	0.92%	544	1,313
1:00	0.74%	556	0.75%	444	999
2:00	0.50%	379	0.59%	348	727
3:00	0.62%	468	0.82%	489	958
4:00	0.69%	523	1.25%	741	1,263
5:00	1.26%	955	2.74%	1627	2,582
6:00	2.34%	1,769	4.95%	2940	4,709
7:00	3.10%	2,343	6.15%	3652	5,995
8:00	3.57%	2,696	5.02%	2977	5,673
9:00	4.06%	3,065	4.57%	2709	5,774
10:00	5.34%	4,029	4.58%	2717	6,746
11:00	5.99%	4,521	5.33%	3160	7,681
12:00 PM	6.34%	4,784	5.85%	3474	8,258
1:00	6.54%	4,939	6.38%	3785	8,724
2:00	7.23%	5,462	6.32%	3749	9,211
3:00	7.63%	5,762	7.32%	4341	10,103
4:00	7.55%	5,703	6.92%	4107	9,810
5:00	7.63%	5,759	6.16%	3658	9,417
6:00	5.98%	4,517	5.86%	3475	7,992
7:00	5.49%	4,147	5.04%	2988	7,135
8:00	5.27%	3,983	4.25%	2520	6,503
9:00	5.36%	4,048	3.55%	2104	6,151
10:00	3.36%	2,540	2.88%	1708	4,248
11:00	2.38%	1,798	1.82%	1079	2,877
TOTAL	100.0%	75,516	100.0%	59,334	134,850

K-Factor is the proportion of Average Daily Traffic (ADT) occurring in the analysis hour.

The future constrained traffic can be expected to result in longer queues and increased travel times in the vicinity of the Bay Bridge. These longer queues will be compounded by the other existing and growing queues along the US 50 corridor. In addition, it is expected that some drivers would choose alternate departure times (peak spreading), find alternate routes to their ultimate destination (diversion), or not make certain types of trips.

Average Weekday. Hourly distribution of directional traffic for year 2025 was developed based on K-factors derived from the 24-hour counts conducted on Wednesday, October 17, 2001. The directional K-factors and hourly distribution for 2025 are shown in **Table 17**.

Table 17. 2025 Unconstrained Hourly Volumes

AVERAGE WEEKDAY					
START TIME	**Weekday EB K-FACTOR**	**2025 EB TOTAL**	**Weekday WB K-FACTOR**	**2025 WB TOTAL**	**Total**
12:00 AM	1.09%	468	0.82%	351	819
1:00	0.77%	330	0.66%	285	615
2:00	0.78%	336	0.54%	234	570
3:00	0.71%	306	0.99%	425	731
4:00	0.86%	368	1.87%	804	1,172
5:00	1.51%	650	4.66%	1,999	2,649
6:00	2.86%	1,227	8.26%	3,547	4,774
7:00	4.02%	1,727	10.12%	4,344	6,071
8:00	4.40%	1,891	8.33%	3,576	5,467
9:00	4.78%	2,054	6.18%	2,653	4,707
10:00	4.98%	2,136	5.16%	2,216	4,352
11:00	5.03%	2,159	5.12%	2,200	4,359
12:00 PM	5.27%	2,263	5.13%	2,201	4,464
1:00	5.15%	2,210	5.05%	2,166	4,376
2:00	6.01%	2,580	5.52%	2,370	4,950
3:00	7.92%	3,402	5.79%	2,484	5,886
4:00	9.71%	4,170	5.75%	2,471	6,641
5:00	9.76%	4,189	5.57%	2,393	6,582
6:00	8.20%	3,520	4.48%	1,925	5,445
7:00	4.96%	2,130	3.30%	1,418	3,548
8:00	3.68%	1,579	2.50%	1,073	2,652
9:00	3.35%	1,437	2.03%	872	2,309
10:00	2.44%	1,049	1.30%	559	1,608
11:00	1.76%	757	0.87%	373	1,130
TOTAL	100.0%	42,938	100.0%	42,939	85,877

3.3.3 Capacity Analysis

Summer Saturday. Future hourly volumes were analyzed for both normal operating conditions as well as contraflow operations.

<u>Capacity Analysis – Normal Operations</u> Eastbound traffic flows across the Bay Bridge were analyzed as a two-lane freeway segment and westbound flows were analyzed as a three-lane freeway segment. The resulting unconstrained levels of service for several of the heaviest volume hours of the day are shown in **Table 18** and on **Figure 8** using LOS threshold volumes. Based on the projected unconstrained hourly distribution, the eastbound bridge will operate at LOS “F” between the hours of 10 AM and 10 PM when

the bridges are operating under normal conditions (two eastbound lanes). The westbound bridge operates at LOS "D" or better for most of the day under normal conditions (three westbound lanes). Capacity analysis worksheets are included in **Appendix G (Volume II)**.

Table 18. 2025 Unconstrained Hourly Level of Service (LOS) – Normal Operations

SUMMER SATURDAY				
START TIME	**2025 EB TOTAL**	**LOS**	**2025 WB TOTAL**	**LOS**
10:00 AM	4,029	F	2,717	B
11:00	4,521	F	3,160	C
12:00 PM	4,784	F	3,474	C
1:00	4,939	F	3,785	C
2:00	5,462	F	3,749	C
3:00	5,762	F	4,341	D
4:00	5,703	F	4,107	C
5:00	5,759	F	3,658	C
6:00	4,517	F	3,475	C
7:00	4,147	F	2,988	C
8:00	3,983	E	2,520	B
9:00	4,048	F	2,104	B

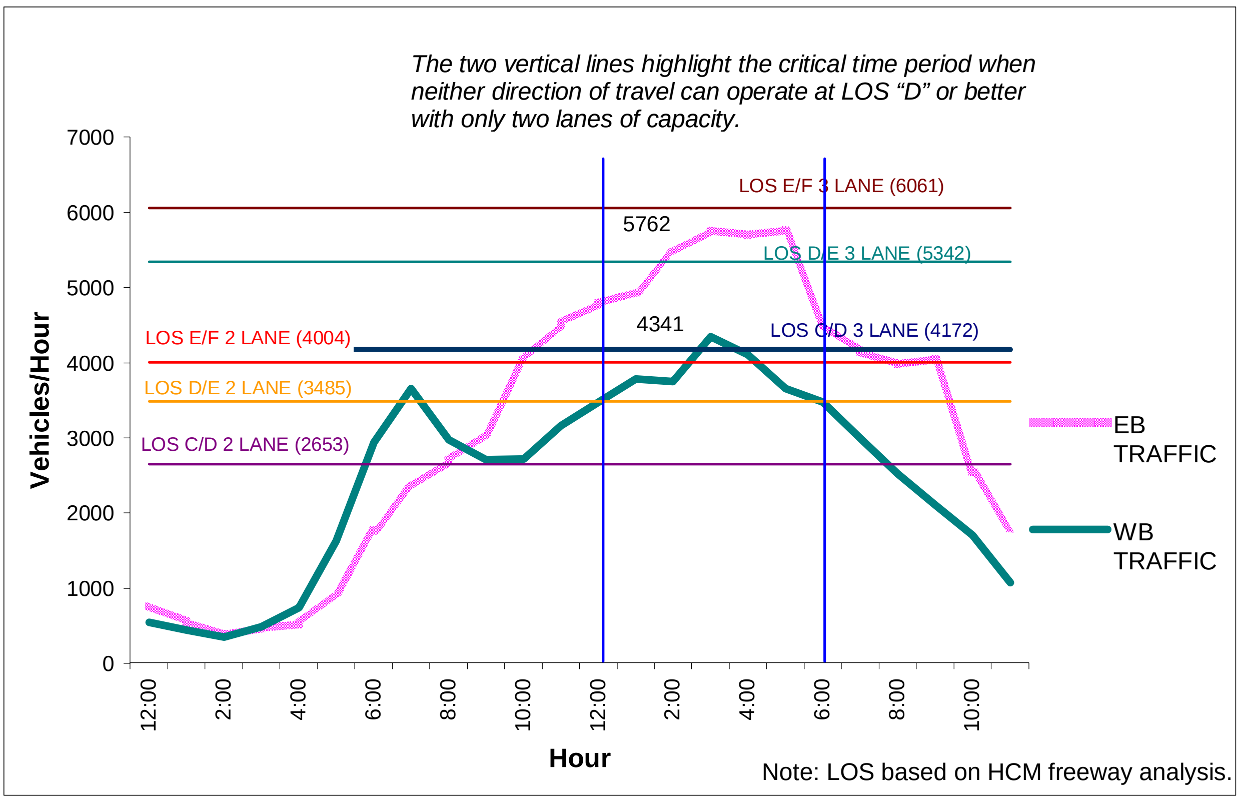


Figure 8. 2025 Unconstrained Hourly Volume Distribution Summer Saturday – Normal Operations

Capacity Analysis – Reversible Lane Operations For contraflow lane operations during times of peak directional flow, two of the lanes on the three-lane westbound bridge remain open for westbound traffic and the third lane is opened to eastbound traffic. The Highway Capacity Manual does not have a set of procedures to evaluate this type of reversible lane operation. Therefore, to calculate LOS for multi-lane traffic with adjacent opposing traffic, the LOS for westbound traffic was estimated by analyzing the traffic as a two-lane, two-way highway (for the middle lane on the westbound bridge) and a multi-lane highway (for the outside westbound lane). Actual percentage volumes per lane were used for this analysis. Similarly, the eastbound traffic was analyzed as a two-lane, two-way highway for the traffic on the westbound bridge and a two-lane freeway for traffic on the eastbound bridge. **Figure 7**, shown on page 2-18, shows typical reversible lane usage on the Bridge.

The unconstrained levels of service for the period from 10 AM to 10 PM are shown in **Table 19** for both contraflow lane operations and normal operations. As seen from this table, during periods of peak flow in both directions, contraflow operations only slightly improve the LOS for four of the 12 hours (6 PM to 10 PM) in the eastbound direction and a majority of the hours remain at undesirable levels of service. In the westbound direction the LOS deteriorates to undesirable levels for seven hours in the westbound direction due to the contraflow lane operations. On **Figure 8**, the two vertical lines highlight the critical time period when neither direction of travel can operate at LOS "D" or better with only two lanes of capacity. Therefore, during this time contraflow operations would fail to meet the capacity needs. As with the existing conditions, westbound congestion on a typical Saturday in the summer would occur as the result of contraflow operations.

Table 19. 2025 Unconstrained Hourly Level of Service- Contraflow Operations

SUMMER SATURDAY								
	EASTBOUND				WESTBOUND			
START TIME	2025 EB TOTAL TRAFFIC VOLUME	Level of Service			2025 WB TOTAL TRAFFIC VOLUME	Level of Service		
		Normal Operations (Lanes 4, 5)	Contraflow Operations			Normal Operations (Lanes 1,2,3)	Contraflow Operations	
			Lane 4, 5[1]	Lane 3[2]			Lane 1[3]	Lane 2[4]
10:00 AM	4,029	F	E	E	2,717	B	D	E
11:00	4,521	F	E	E	3,160	C	D	E
12:00 PM	4,784	F	F	F	3,474	C	E	F
1:00	4,939	F	F	F	3,785	C	E	F
2:00	5,462	F	F	F	3,749	C	E	F
3:00	5,762	F	F	F	4,341	D	F	F
4:00	5,703	F	F	F	4,107	C	F	F
5:00	5,759	F	F	F	3,658	C	E	F
6:00	4,517	F	E	F	3,475	C	E	F
7:00	4,147	F	E	E	2,988	C	D	E
8:00	3,983	E	D	E	2,520	B	C	E
9:00	4,048	F	E	E	2,104	B	C	E

Lane numbers correspond to lanes shown in Figure 7.

Average Weekday. Future hourly volumes were analyzed for both normal operating conditions as well as contraflow operations.

Capacity Analysis – Normal Operations Eastbound traffic flows across the Bay Bridge were analyzed as a two-lane freeway segment and westbound flows were analyzed as a three-lane freeway segment. The resulting unconstrained levels of service for several of the heaviest volume hours of the day are shown in **Table 20** and on **Figure 9** using LOS threshold volumes.

The eastbound bridge would experience queuing and delays operating at LOS "F" between 4 PM and 6 PM and at LOS "E" from 6 PM to 7 PM. The westbound bridge operates at satisfactory levels of service during most of the day. Capacity analysis worksheets are included in **Appendix G (Volume II)**.

Table 20. 2025 Unconstrained Hourly Level of Service (LOS) – Normal Operations

AVERAGE WEEKDAY				
START TIME	**2025 EB TOTAL**	**LOS**	**2025 WB TOTAL**	**LOS**
6:00 AM	1,227	B	3,547	C
7:00	1,727	B	4,344	D
8:00	1,891	C	3,576	C
9:00	2,054	C	2,653	B
10:00	2,136	C	2,216	B
11:00	2,159	C	2,200	B
12:00 PM	2,263	C	2,201	B
1:00	2,210	C	2,166	B
2:00	2,580	C	2,370	B
3:00	3,402	D	2,484	B
4:00	4,170	F	2,471	B
5:00	4,189	F	2,393	B
6:00	3,520	E	1,925	B
7:00	2,130	C	1,418	A
8:00	1,579	B	1,073	A
9:00	1,437	B	872	A

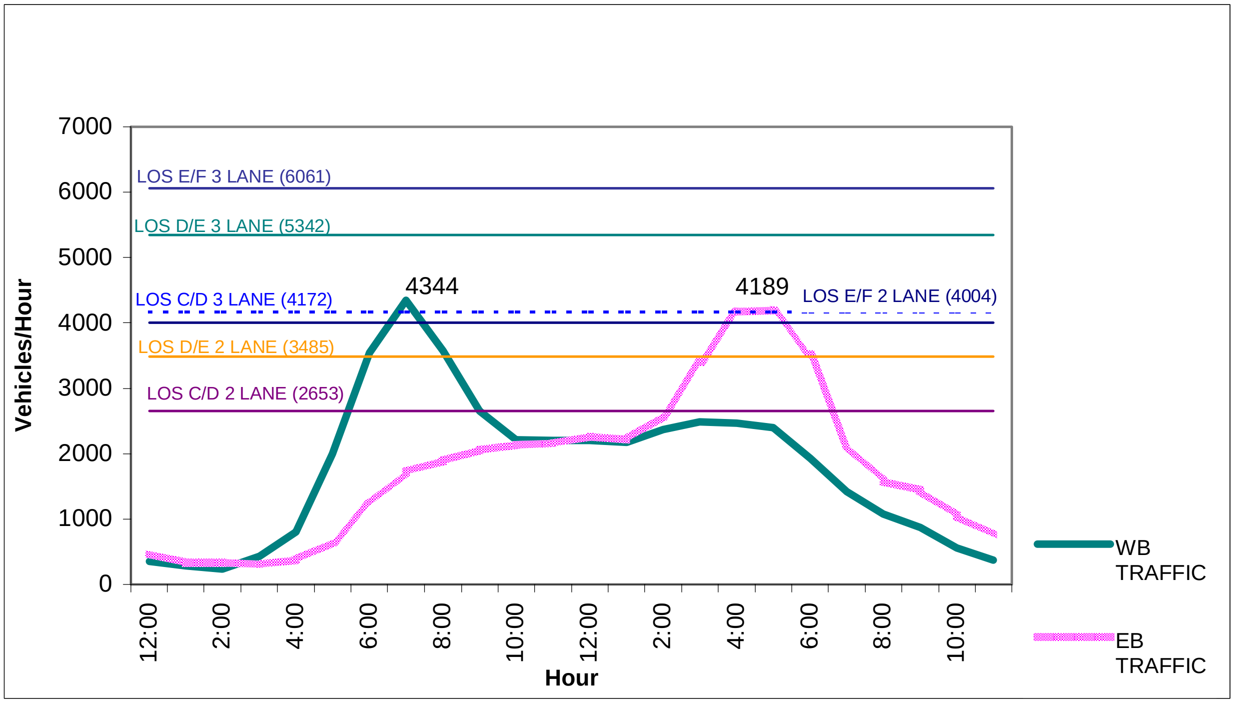


**Figure 9. 2025 Unconstrained Hourly Volume Distribution
Average Weekday – Normal Operations**

<u>Capacity Analysis - Reversible Lane Operations</u> The reversible lane operation is currently utilized for normal weekday operation only on an “as-needed” basis. The same methodology that was used for the existing analysis was applied for the future analysis and only the peak periods where the volumes were at or beyond capacity for normal operation were analyzed.

The unconstrained levels of service for the period from 4 PM to 7 PM are shown in **Table 21** and compared to LOS for normal operations. As seen from this table, during periods of peak flow in both directions, contraflow lane operations improve the LOS for two of the three hours in the eastbound direction but the westbound direction LOS deteriorates to near capacity for the same two hours for the inner lane of travel.

Table 21. 2025 Unconstrained Hourly Level of Service (LOS) - Contraflow Operations

AVERAGE WEEKDAY								
	EASTBOUND				WESTBOUND			
START TIME	2025 EB Total Traffic Volume	Level of Service			2025 WB Total Traffic Volume	Level of Service		
		Normal Operations (Lanes 4, 5)	Reversible Operations			Normal Operations (Lanes 1, 2 & 3)	Reversible Operations	
			Lanes 4 & 5[1]	Lane 3[2]			Lane 1[3]	Lane 2[4]
4:00 PM	4,170	F	D	D	2,471	B	C	E
5:00	4,189	F	D	D	2,393	B	C	E
6:00	3,520	E	E	D	1,925	B	C	D

Lane numbers correspond to lanes shown in Figure 7.

[1] 80 Percent of Eastbound Traffic on Eastbound Bridge (Lanes 1 & 2).

[2] 20 Percent of Eastbound Traffic on Westbound Bridge (Lane 3).

[3] 55 Percent of Westbound Traffic in Outer Lane (Lane 1).

[4] 45 Percent of Westbound Traffic in Inner Lane (Lane 2).

4

SUMMARY AND CONCLUSIONS

4.1 Study Area

The Bay Bridge study area extends a distance of 5.8 miles along U.S. Route 50/301, between the Oceanic Drive overpass in Anne Arundel County and the MD 8 overpass in Queen Anne's County. Within the study limits, U.S. Route 50/301 includes two parallel steel bridge structures, collectively known as the Bay Bridge, that span 4.3 miles, from shore to shore, across the Chesapeake Bay. It is the only roadway crossing of the Chesapeake Bay in Maryland.

The areas in the vicinity of the Bay Bridge have seen high levels of population and employment growth for the past several decades. This growth is projected to increase for the next ten years at a pace greater than the rest of the Baltimore-Washington region.

The Bay Bridge serves as a critical link in connecting several priority funding areas (PFA) on either side of the Chesapeake Bay. These PFAs, targeted for future economic development and growth, include the City of Annapolis and the community of Arnold, in Anne Arundel County on the west side of the Bridge and portions of Kent Island, Stevensville, and Grasonville, in Queen Anne's County on the east side of the bridge.

4.2 Roadway Geometry

The eastbound bridge was opened over 50 years ago and originally served traffic in both the eastbound and westbound directions. It now carries two lanes of eastbound traffic. The second bridge opened 30 years ago and carries three lanes of westbound traffic. This lane configuration represents normal operating conditions. Contraflow lane operation is used during periods of peak congestion, incident response, or construction and maintenance activities.

U.S. 50/301 is a six-lane divided highway on both approaches to the Bay Bridge. There is an 11-lane toll plaza west of the Bridge that provides one-way toll collection for eastbound vehicles. There are also transition areas on each side of the bridge to allow for contraflow operations. The transition and lane shift designs meet current minimum American Association of State Highway and Transportation Officials (AASHTO) standards and allow for a smooth transition of traffic to/from either bridge.

From a geometric review standpoint, the three percent grade on the eastbound and westbound bridges is within desirable AASHTO guidelines for urban arterials. However, the steepness of the grade in combination with a stop condition for traffic passing through the eastbound toll plaza, results in heavy vehicles traveling below the posted speed causing some delay for all vehicles using the eastbound bridge. AASHTO guidelines recommend minimal safety offsets on long span bridges. Both bridges have approximately one-foot offsets between travel lanes and the bridge rails leaving no room for disabled vehicles to pull out of the traveled lanes. Disabled vehicles routinely block traffic. The loss of a lane due to a disabled vehicle or other incident management activities can have a significant impact on the vehicular capacity of the bridges.

4.3 Travel Patterns

On an average summer Saturday, 82 percent of the eastbound traffic using the Bay Bridge comes from the Baltimore-Washington metropolitan area. Twenty-four percent of the traffic is destined to Queen Anne's and Kent counties with another 24 percent destined to other locations on Maryland's Eastern Shore, excluding Ocean City. Ocean City and the Delaware Beach resorts attract 23 percent and 20 percent of the traffic, respectively. During the summer Saturday, 83 percent of the trips begin at home and 37 percent are destined to recreation or tourism activities.

On an average weekday 93 percent of eastbound traffic using the Bay Bridge comes from the Baltimore-Washington metropolitan area. Fifty-two percent of the traffic is destined to Queen Anne's and Kent counties with another 35 percent destined to Maryland's Eastern Shore, including Ocean City. On an average weekday, 85 percent of the trips began at work or home and 77 percent end at work or home.

4.4 Travel Demand and Traffic Operations

The Bay Bridge carries approximately 53 percent more traffic on an average Saturday in summer (92,000 vehicles) than on an average weekday (60,000 vehicles). By 2025, the daily volumes are expected to increase to approximately 135,000 vehicles on an average Saturday in summer and 86,000 vehicles on an average weekday.

Trucks account for approximately five percent of total traffic on an average summer Saturday and approximately 14 percent on an average weekday. The trucks travel predominantly in the non-peak periods; however, the truck percentage of 14 percent for an average weekday significantly exceeds the Statewide average of four percent on other urban arterials.

The increased volumes of traffic on summer weekends cause the section of U.S. Route 50/301 approaching the toll plaza to experience significant congestion queuing. The queues usually start to build on Friday around midday and last into the evening (approximately 6 to 7 PM). The queues tend to be longer during summer holiday weekends such as Memorial Day and Independence Day. These queues occur even when all eleven-toll lanes are open and contraflow operations are used to maximize the Bridge's vehicular capacity in the peak direction of travel.

By the year 2025, the eastbound bridge is expected to operate at level of service (LOS) "E" or "F" for several hours during the PM peak period for an average weekday. On an average Saturday in summer, the eastbound bridge is expected to operate at LOS "F" between the hours of 10 AM and 10 PM when the bridges are operated under normal conditions. The westbound bridge is expected to operate at LOS “D” or better for most of the day, under normal conditions.

During periods of peak flow in both directions, it is anticipated that contraflow operations will slightly improve the LOS for four of the 12 hours (6 PM to 10 PM) in the eastbound direction and a majority of the hours remain at undesirable levels of service. In the westbound direction the LOS deteriorates to undesirable levels for seven hours of the summer Saturday due to the contraflow operations on the bridge. Westbound congestion is a result of the contraflow operations due to the reduction from three to two westbound lanes.

These levels of service are based on an unconstrained hourly volume assignment that does not take into account congestion on the adjacent street network, at the toll plaza or on the Bridge. Under constrained traffic conditions, it is expected that the hours of congestion will increase due to peak spreading (drivers selecting alternative travel times to avoid peak congestion). In addition, it is anticipated that some drivers would select alternative routes or cancel certain types of discretionary trips. The future constrained traffic can be expected to result in longer queues and increased travel times in the vicinity of the Bay Bridge. These longer queues will be compounded by the other existing and growing queues along the US 50 corridor.

4.5 Maintenance

Based on the current condition of the eastbound bridge deck and the projected increases in traffic volumes, it is anticipated that the deck will require rehabilitation by 2018. Depending on the type and method of construction, the rehabilitation could require long-term single lane closures or complete nighttime bridge closures of the eastbound bridge. Because the bridge is projected to carry significant traffic volumes by 2018, the rehabilitation would likely result in substantial travel time delays.

4.6 Safety

Accident data analyzed for the period from January 1999 to October 2002 show a total of 402 accidents in the study area. Approximately 60 percent of the collisions are rear-end accidents which are frequently associated with traffic congestion. The study area’s rate for rear-end collisions is significantly higher than the Statewide rates for both urban and rural arterials.

Approximately 39 percent of the accidents occur in the summer months of June, July, and August, which account for approximately 35 percent of the annual Vehicle Miles of Travel (VMT). Of these summer accidents, 60 percent occurred on a Friday, Saturday, or Sunday. Approximately half of the total accidents occur on weekends (Friday, Saturday, Sunday) with 45 percent of them occurring on Fridays. The total daily traffic volume on an average Friday in the summer is approximately 40 percent higher than the average annual daily traffic.

Approximately 27 percent of accidents involve trucks resulting in a truck accident rate that is significantly higher than the statewide rate for the urban portion of the study area and slightly over the statewide rate for the rural portion of the study area. This correlates with a higher than average percent of trucks in the study area (five percent for average Saturday in summer and 14 percent for average weekday).

Almost 90 percent of the accidents occur under dry weather conditions and 85 percent occur during the day indicating that neither wet pavement nor lighting is a major contributor to accidents in the study area.

While the largest number of accidents occurs on the bridge structure, the largest occurrence of accidents in proportion to the length of the segment occurs on the west approach roadway. Thirty-five percent of the accidents on the west approach roadway occurred in the immediate vicinity of the tollbooths and were mostly fixed object collisions. Another concentration of accidents occurred at the beginning of the bridge.

Finally, the probable cause listed on the police reports for 53 percent of the accidents was "failure to give full attention" which may be a result of drivers being distracted by the volume of traffic, geometric conditions, other vehicle occupants, in-vehicle electronic devices, scenery and/or unfamiliar roadways. In addition, eastbound drivers traveling through the toll plaza can be distracted while trying to find money for the toll or putting away change and/or receipts.

4.7 Conclusion

The transportation needs identified in this study primarily relate to capacity, safety, and maintenance requirements. The existing needs are projected to continue and worsen into the future.

The Bay Bridge currently experiences LOS "E/F" in the eastbound direction for several hours during the summer weekend peak periods. By 2025, it is anticipated to operate at LOS "E/F" for an extended period of time (12 hours a day) on summer Saturdays and for several hours during average weekday PM peak periods. The westbound bridge is expected to operate at LOS "D" or better for most of the day, under normal conditions.

The current contraflow lane operation that is used to increase peak direction capacity is not expected to mitigate the LOS. During periods of peak flow in both directions, it is anticipated that contraflow operations would improve the LOS for four of the 12 hours in the eastbound direction and in the westbound direction the LOS is anticipated to deteriorate to LOS "F" for seven hours on summer Saturdays. Westbound congestion is a result of the contraflow operations when westbound traffic is restricted to two rather than three travel lanes on the bridge.

The future constrained traffic can be expected to result in longer queues and increased travel times in the vicinity of the Bay Bridge. These longer queues will be compounded by the other existing and growing queues along the US 50 corridor.

The bridge capacity is reduced by the lack of a climbing lane for trucks, which make up more of the vehicle composition than on similar types of facilities. In addition, the bridge's lack of shoulders to accommodate disabled vehicles outside the travel lanes further reduces capacity.

Approximately 60 percent of the collisions in the study area are rear-end accidents which are frequently associated with traffic congestion. The study area's rate for rear-end collisions is significantly higher than the Statewide rates for both urban and rural arterials.

Finally, planned future maintenance and rehabilitation of the eastbound Bay Bridge could require long-term single lane closures or complete nighttime bridge closures of the eastbound bridge which would likely result in substantial travel time delays.

The transportation needs for the Bay Bridge outlined in this report should be looked at in the context of the larger transportation facility along the US 50 corridor.

A

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Mr. Doug Novocin, Engineering Division (Highways)
Mr. Charles Ray, Facility Manager, Francis Scott Key Bridge

Metropolitan Washington Council of Governments
Mr. Michael Clifford, Systems Planning Application Director
Mr. J.C. Park, Transportation Engineer

Rappahannock Area Development Commission
Mr. Stephen Manster, Executive Director

Johnson, Mirmiran & Thompson

Mr. Matt Wolniak, Vice President

Parsons

Mr. Bala Akundi, Senior Transportation Engineer
Ms. Maureen Decker, Senior Transportation Engineer
Mr. Joseph Springer, Senior Transportation Planner
Ms. Harriet K. Levine, Senior Transportation Engineer
Mr. Stephen C. Walter, Vice President

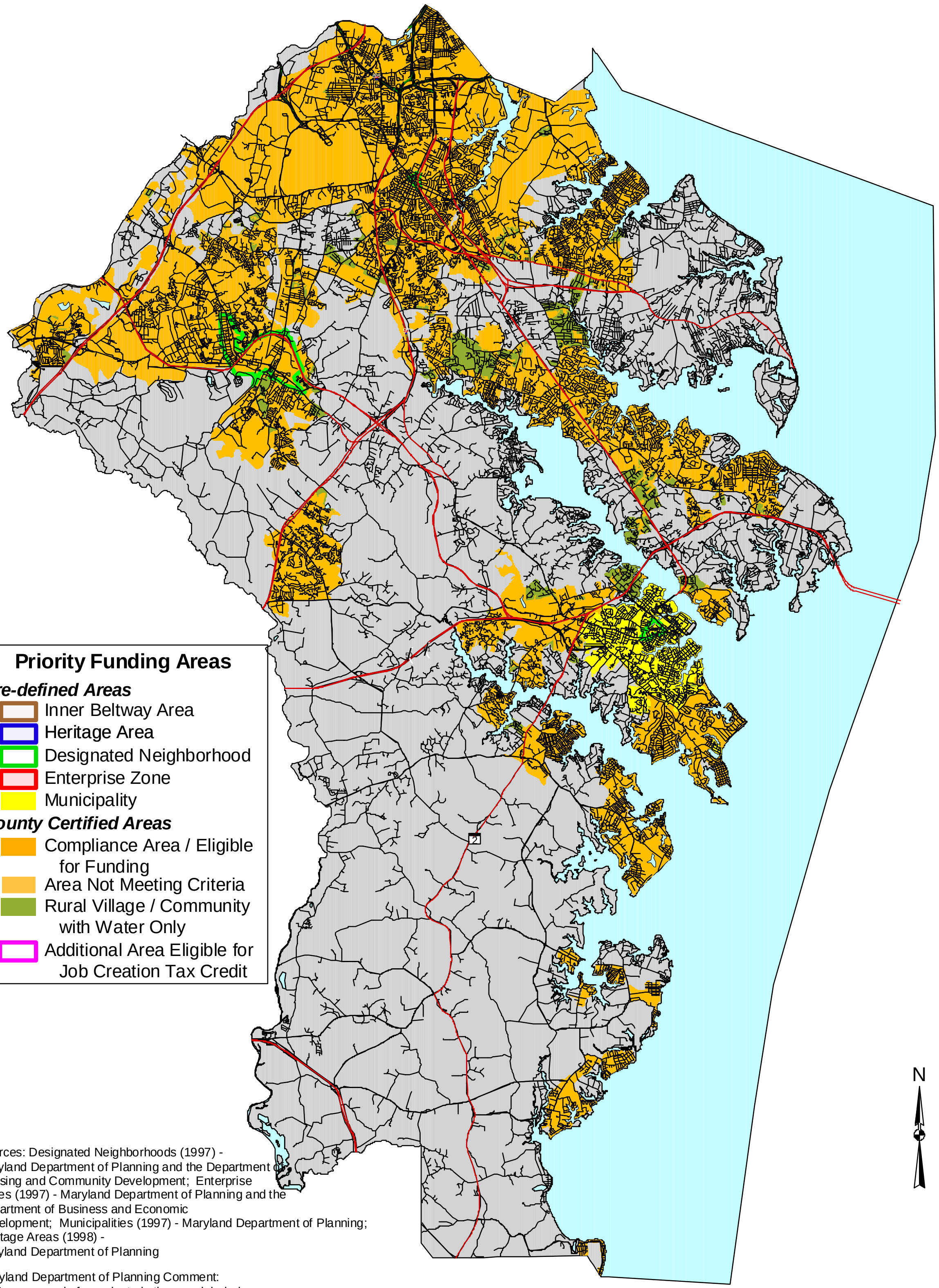
KCI Technologies, Inc.

Mr. Harvey Floyd, Principal-in-Charge
Mr. Steve Drumm, Senior Highway Engineer
Ms. Angela Jones, Planner

B

PRIORITY FUNDING AREA MAPS

ANNE ARUNDEL COUNTY
Priority Funding Areas

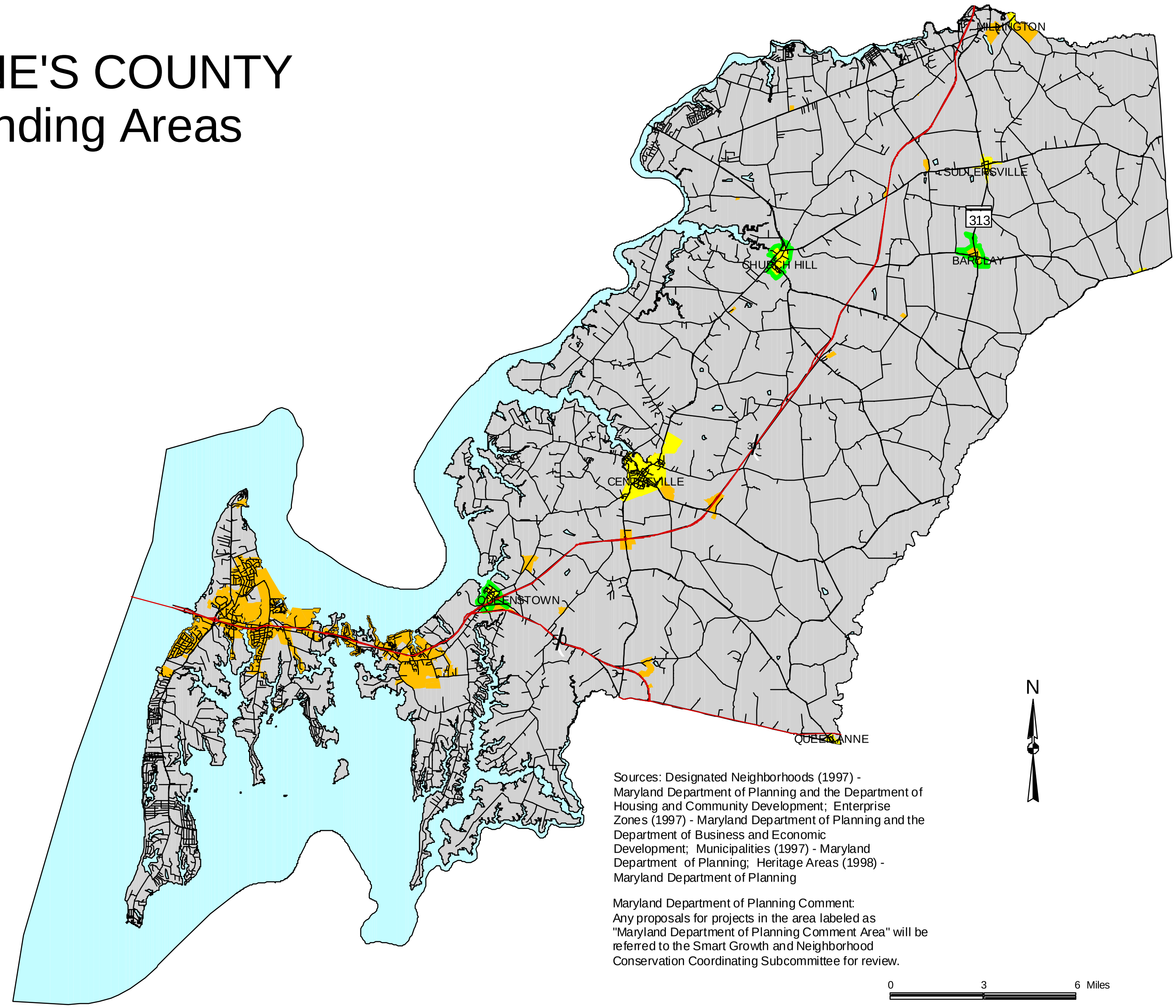


Sources: Designated Neighborhoods (1997) - Maryland Department of Planning and the Department of Housing and Community Development; Enterprise Zones (1997) - Maryland Department of Planning and the Department of Business and Economic Development; Municipalities (1997) - Maryland Department of Planning; Heritage Areas (1998) - Maryland Department of Planning

Maryland Department of Planning Comment:
Any proposals for projects in the area labeled as " Area not meeting criteria" will be referred to the Smart Growth and Neighborhood Conservation Coordinating Subcommittee for review.

Maryland Department of Planning
Planning Coordination & Resource Management
Current as of October 2001

QUEEN ANNE'S COUNTY
Priority Funding Areas



Priority Funding Areas

Pre-defined Areas

- Inner Beltway Area
- Heritage Area
- Designated Neighborhood
- Enterprise Zone
- Municipality

County Certified Areas

- Compliance Area / Eligible for Funding
- Area Not Meeting Criteria
- Rural Village / Community with Water Only
- Additional Area Eligible for Job Creation Tax Credit

Sources: Designated Neighborhoods (1997) - Maryland Department of Planning and the Department of Housing and Community Development; Enterprise Zones (1997) - Maryland Department of Planning and the Department of Business and Economic Development; Municipalities (1997) - Maryland Department of Planning; Heritage Areas (1998) - Maryland Department of Planning

Maryland Department of Planning Comment:
Any proposals for projects in the area labeled as "Maryland Department of Planning Comment Area" will be referred to the Smart Growth and Neighborhood Conservation Coordinating Subcommittee for review.

MDP Maryland Department of Planning
Planning Coordination & Resource Management
Current as of March 4, 2002

C

AERIAL FIGURES

FIGURE C–1

BAY BRIDGE (WEST APPROACH)

SCALE 1:200

50 0 100 200 FEET

FIGURE C-2

BAY BRIDGE (EAST APPROACH)

SCALE 1:200

50 0 100 200 FEET