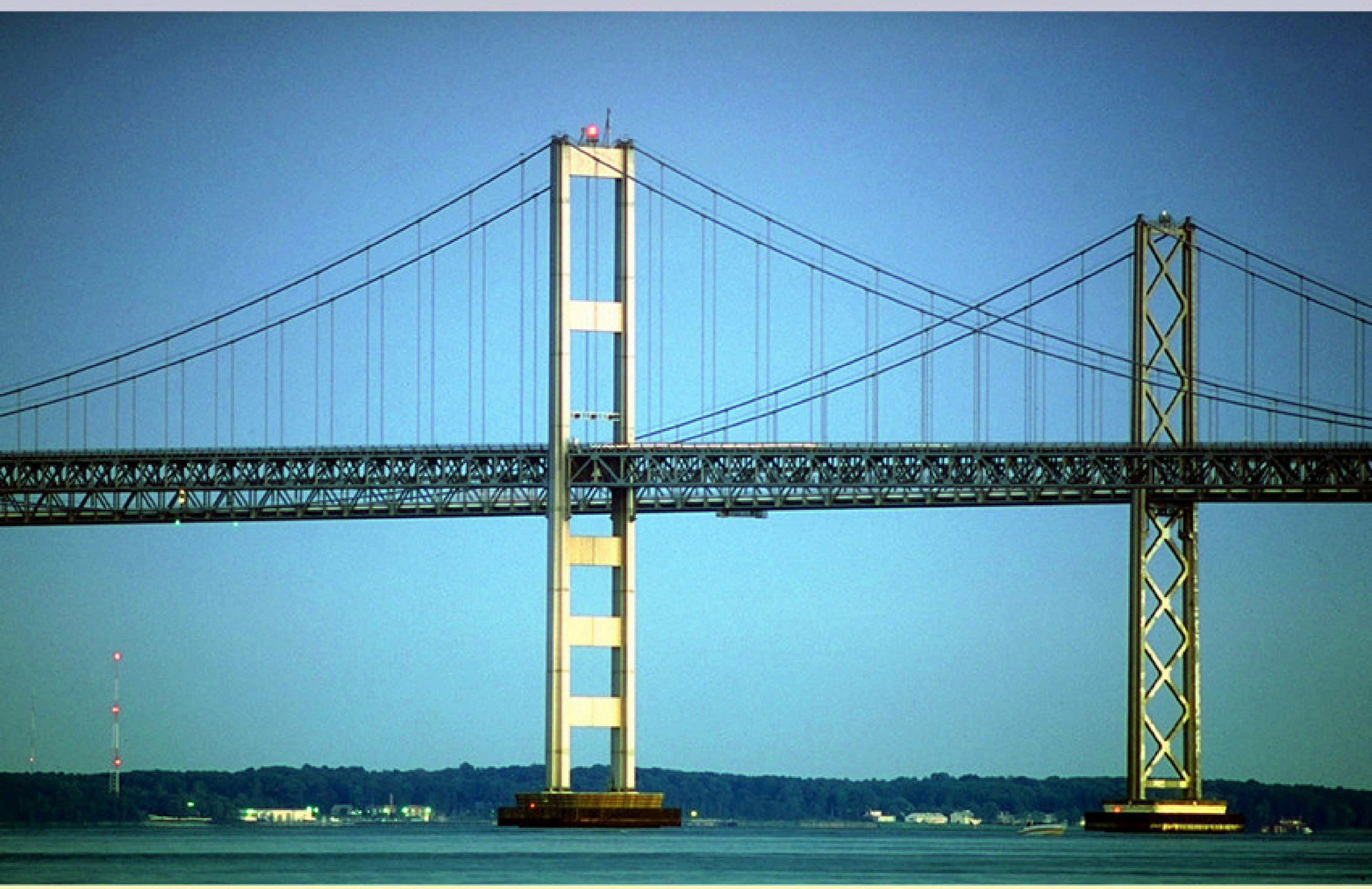
Analysis of Transit Only Concepts To Address Traffic Capacity Across the Chesapeake Bay



Maryland Transportation Authority

MTA Maryland

September 28, 2007

Analysis of Transit Only Concepts To Address Traffic Capacity Across the Chesapeake Bay

FINAL REPORT

September 28, 2007

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

In 2001, the Maryland Transportation Authority (Authority) initiated a study of the transportation and safety needs associated with the existing William Preston Lane, Jr. Memorial (Bay) Bridge. The 2004 Bay Bridge Needs Report was the result of that study and presented the assessment of existing and future operations and safety of the Bridge. It is well documented that the US50/US301 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/US301 corridor that is the most susceptible to factors that can cause or exacerbate congestion. For example, because the Bridge lacks shoulders, reconstruction and rehabilitation work takes longer and creates difficulties with maintaining traffic flow. In addition, the US 50/US 301 corridor serves as a regional alternate to I-95 and US 13. The lack of an alternative crossing could be a concern in terms of homeland security. It is anticipated that the deck of the eastbound span 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 nighttime bridge closures of the eastbound span. Because the Bridge is projected to carry significantly higher traffic volumes by 2015-2020, the rehabilitation would likely result in substantial travel time delays.

In 2005, the Task Force on Traffic Capacity Across the Chesapeake Bay convened five times between May and December to examine the range of issues associated with the need for additional traffic capacity across the Bay. The Task Force received detailed information from several state agencies on the history of the existing Bridge spans, the transportation and safety needs identified in the 2004 Bay Bridge Needs Report, construction of major water crossings, traffic forecasts, the environmental review and regulatory process, and growth and economic development. In addition, the Authority held five public information meetings to share information presented to the Task Force with a broader public audience and to receive public input.

Based on the information presented to them and their discussions of the material, the Task Force members recognized that there is a need for sufficient and reliable capacity for travel across the Bay. The Task Force members recognized that State leaders must also consider how to protect and manage Maryland's rural and urban communities and other valuable resources while determining how to address this need. The comments and suggestions from the Task Force members, elected officials who were briefed during the process and citizens who attended the workshops indicated that the issue of traffic capacity across the Bay is complex and requires more detailed study.

Some Task Force members and public commenters expressed an interest in transit service in lieu of additional highway capacity. To respond to this interest and begin to understand the role of transit in addressing the needs at the existing bridge, the Authority conducted this study of transit-only concepts (in lieu of new highway capacity), prior to any studies of highway alternatives, to determine whether transit service across the Bay would be viable, cost effective and able to address the capacity needs at the existing Bay Bridge without any additional highway capacity. The team assumed that any transit-only concepts would use the existing Bay Bridge or a newly-constructed crossing at the location of the current bridge to maximize the potential cost-effectiveness of any transit-only concept and to use the information that is already available for the existing bridge.

For the 2004 Bay Bridge Needs Report, a sketch-level model was used to forecast future travel across the Bay Bridge. The traffic data forecasted by the sketch-level model was appropriate for the preliminary nature of the Needs Report but was not expected to meet the needs of more detailed future studies. The Authority subsequently developed the Integrated Bay/Nice Travel Forecasting Model (IBNM) which is more sophisticated and refined than the previous model. For the Transit Study, the study team used the IBNM to evaluate the origins and destinations of vehicles that use the Bay Bridge. The study team conducted the following;

- Used the IBNM to identify those combinations of origins/destinations that might hold potential for a transit-only concept.
- Projected the ridership for those transit-only concepts and researched industry standards for transit ridership for comparison.
- Estimated the level of congestion relief at the existing bridge based on how much of the projected demand could be met by the most promising transit-only concept.
- Developed sketch level cost estimates for heavy rail, light rail and bus rapid transit to evaluate the benefits of the cost-effective transit-only concepts.

The results of the study indicate that transit service alone will not provide a significant benefit to summer weekend or peak period weekday traffic. Ridership projections are significantly lower than the minimum thresholds for heavy rail transit (HRT), light rail transit (LRT), and bus rapid transit (BRT). While transit service would reduce vehicle travel on the Bay Bridge, the reduction would likely be very small relative to the overall volume of traffic that uses the bridge. For example, on a summer weekend day, about eastbound 54,600 vehicle trips are made across the Bay Bridge and 109,600 eastbound vehicle trips are projected to be made in 2030 (which would exceed the capacity of the Bridge). Note that the full day summer weekend day volume in both directions is approximately 91,000 today and is projected to be 182,700 in 2030. On a summer weekend day, approximately 2,900 people would switch to transit by 2030, which equates to about 1,250 fewer cars on the bridge traveling to the Eastern Shore on a weekend day, or a 1.1 percent reduction in auto use. For weekday peak period traffic traveling westbound, approximately 870 people would switch to transit by 2030. This equates to about 620 fewer cars on the Bridge each morning traveling westbound, or a 4.3 percent reduction in auto use. In both cases, however, the traffic operations of the Bay Bridge are predicted to fail, with or without the transit-only route in place. One explanation for the low ridership is that the land uses and population and employment densities on the Eastern Shore would not support a fixed guideway or BRT service In addition, estimated initial construction costs could be on the order of several billion dollars (not including construction of a new bridge to carry the transit service).

However, because transit is projected to attract ridership and provide some congestion relief at the existing Bay Bridge, it is clear that transit could be an important component of any future studies on additional capacity across the Chesapeake Bay.

THE BAY BRIDGE TRANSIT STUDY

Background and Purpose of the Study

Traffic across the Bay Bridge has been increasing steadily since the parallel spans were constructed; the original two-lane bridge in 1952 and the second three-lane bridge in 1973. Since 1952, population and job growth on both sides of the Chesapeake Bay have increased significantly, resulting in an increase in the volumes of local and regional trips, and increased congestion and its associated effects (e.g., accidents, increased truck traffic, delays, environmental concerns, and others).

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 with safe and convenient transportation facilities, the Authority is evaluating the need for additional capacity across the Chesapeake Bay. In 2001, the Authority initiated a study of the transportation and safety needs associated with the existing Bay Bridge. The 2004 Bay Bridge Needs Report was the result of that study and presented the assessment of existing and future operations and safety of the Bay Bridge.

A Task Force on Traffic Capacity Across the Chesapeake Bay was convened in January 2005 with the purpose to gather information and identify issues concerning the existing Bay Bridge, and what alternatives may be available that would provide additional transportation capacity across the Chesapeake Bay in the future. The Task Force reviewed detailed information on the history of the existing bridge spans, the transportation and safety needs identified in the 2004 Bay Bridge Needs Report, construction of major water crossings, traffic forecasts, the environmental review and regulatory process, and growth and economic development.

To respond to some of the Task Force members' and public commenters' interest in transit service in lieu of additional highway capacity, the Authority initiated this study of transit-only concepts. The purpose is to determine whether transit service across the Bay would be viable, cost effective and able to address the capacity needs at the existing Bay Bridge without any additional highway capacity. The team assumed that any transit-only concepts would use the existing Bay Bridge or a newly-constructed crossing at the location of the current bridge to maximize the potential cost-effectiveness of any transit-only concept and to use the information that is already available for the existing Bridge. In addition, the transit-only concepts considered were assumed to be fixed guideway or dedicated transitways systems, which would include heavy rail transit (HRT), light rail transit (LRT), or bus rapid transit (BRT) systems. The results of this study will be used to inform the public as well as to form the basis for future analyses of transit concepts.

Technical Methodology

The goal of this preliminary transit-only study is to determine whether fixed guideway (HRT or LRT) or dedicated transitway (BRT) concepts are viable, can adequately address traffic demands and capacity needs, and are cost effective at the existing Bay Bridge without any additional highway capacity. For the purposes of this preliminary study, transit-only concepts will be assumed to cross the existing Bay Bridge or cross at a newly-constructed crossing at the location of the existing Bridge. This approach was used to maximize the potential cost-effectiveness of any transit-only concept and to use the information that is already available for the existing Bridge.

To complete the analysis, the study was conducted in three stages:

- Analysis of origin and destination patterns at the existing Bay Bridge to understand the potential transit routes and ridership on those routes
- Analysis of the potential traffic relief at the existing Bay Bridge afforded by the transit-only concepts to determine if transit can adequately address the demand
- Research of national transit standards to compute sketch level costs and supporting measures such as land uses and employment and population densities surrounding transit service to determine if transit-only concepts are cost-effective

Analysis of Potential Transit Routes and Ridership

The first step in the study was to identify and understand the range of origins and destinations for traffic that currently crosses the Bay Bridge, and to identify those combinations of origins/destinations that might hold potential for a transit concept. The study team used both the Origin-Destination (O-D) surveys conducted at the Bay Bridge in 2001 and 2004 and the Integrated Bay/Nice Model that recently was developed for the Authority. To understand the full range of traffic conditions on the Bay Bridge, the study team considered travel patterns both the typical weekday and summer weekend under both existing and future (2030) conditions. The overall trip patterns were identified and used to determine potential transit routes that could serve the highest number of likely transit users. The study team then computed the number of trips most likely to use the potential transit routes (i.e., those trips with destinations served by transit). The next step in this process was then to estimate the percentage of travelers crossing the Bay Bridge that would be likely to use transit if the service was available. These estimates were based on the characteristics of the individual destinations, such as land use density, and the number of trips. For the purposes of this preliminary study, these routes would be assumed to include any type of transit – heavy rail, light rail, and BRT service along existing or planned roadways.

Analysis of Potential Traffic Relief at the Existing Bay Bridge

The study team evaluated the benefits of the transit-only concepts in terms of their ability to reduce congestion at the existing Bay Bridge. Using the results of the analysis of potential transit routes and ridership, and results of the travel demand forecasts, the study team estimated the amount of congestion relief by determining how much of the projected demand could be met by the transit-only concepts. The traffic operations of the bridge were evaluated by determining the percentage of capacity of the existing bridge after the transit trips were subtracted from the total number of vehicle trips projected to use the Bay Bridge.

Analysis of Cost Effectiveness and Supporting Measures

To understand the potential costs of constructing a new exclusive right-of-way transit system, the study team used accepted cost per mile figures for construction costs for heavy rail, light rail, and BRT to develop sketch level cost estimates for the potential routes. In addition to computing the costs of the transit lines themselves, it is important to understand the level and cost of development needed to sustain transit-only service. Therefore, the study team researched previous studies of transit alternatives as well as existing transit routes to develop an understanding of land use densities that are needed to sustain transit service, both in terms of density and range. This research included identification of the current land uses in the area of the existing crossing and origin and destination points and how those land uses are, or are not, consistent with the national standards.

ANALYSIS OF POTENTIAL TRANSIT ROUTES AND RIDERSHIP

The Travel Demand Forecasting Model

To develop transit ridership projections, the study team first needed to understand where transit networks could be developed that would carry travelers from a stop convenient to their origins, such as their home or a park and ride facility, to a stop near their destinations. Development of these trip patterns requires knowledge of existing trips, including trip purposes, trip frequencies, vehicle occupancy, and trip origins and destinations (beginning and ending points), and how growth throughout the region may affect future travel choices. The preferred method of developing these estimates is to use a travel demand forecasting model.

The Authority commissioned development of the Integrated Bay / Nice Travel Demand Forecasting Model (the IBNM) as part of the technical studies for the Chesapeake Bay Bridge and the Harry W. Nice Memorial Bridge carrying US 301 over the Potomac River. The IBNM combines the existing travel demand forecasting models that are maintained by the Delaware Department of Transportation (DelDOT), the Baltimore Metropolitan Council (BMC), the Metropolitan Washington Council of Governments (MWCOG), and the Rappahannock Area Development Commission in Virginia (RADCO). The resulting IBNM covers most of Maryland (with the exception of Western Maryland), Delaware, Washington, DC, and the portion of Virginia that is adjacent to the Potomac River.

The IBNM represents a map of the major roads throughout the region. Many of these roads function as boundaries for small regions identified as Traffic Analysis Zones (TAZs). A TAZ may represent a neighborhood, a community, a business park, or some other entity. Using socioeconomic data specific to each TAZ, such as the land use of the TAZ (e.g., retail, residential, industrial, school), how many households are represented, how large the lots are, and how many jobs are available within the TAZ, the IBNM can predict how many vehicle trips may have their origins or their destinations within each TAZ and how those vehicle trips are assigned to the roads defined in the IBNM.

Trip data compiled through the use of postcard surveys at the Bay and Nice Bridges (where travelers were asked about their trip patterns, trip purposes, and vehicle occupancy) was used to more finely calibrate the model at those locations. Please refer to the Authority's Origin-Destination Study Report for the Bay Bridge and Nice Bridge Needs Study (June 5, 2002). The IBNM therefore provides a sophisticated estimate of travel patterns for vehicle trips crossing the Bay Bridge under typical travel conditions (a weekday), under both existing and future (2030) conditions. In other words, the IBNM can be used to develop trip predictions for any road within the network for existing and future conditions.

The IBNM, like many other travel demand forecasting models, was designed to assess traffic on roadways. As such, each trip in the model represents one vehicle. However, one vehicle does not necessarily represent one person. For analysis of roadways, the occupancy of a vehicle is generally not relevant, only the presence of the vehicle itself. Conversely, for evaluation of transit service, the individual trips made by each person are relevant.

Because the ridership on potential transit lines and the number of vehicles on the Bay Bridge are both relevant to this study, the study team has evaluated both person trips and vehicle trips throughout this study. Research into the results of the 2002 Origin-Destination Study Report mentioned above showed that for a weekday, one vehicle trip is approximately equivalent to 1.4 person trips. For a summer weekend day, one vehicle trip is roughly equivalent to 2.3 person trips.

The IBNM is based on data for a typical weekday. A typical weekday includes daily trips such as work, school, shopping, or doctor's visits. The IBNM and the regional models that comprise the IBNM, like most models, do not consider weekend travel patterns because this period is typically not used to design transportation systems. Few summer weekends, outside of holiday weekends, typically experience significant traffic volumes during a particular portion of a day that exceed those on a weekday. However, the summer weekend day traffic on the Bay Bridge does not follow this trend. Traffic volumes on roadways used to reach the Eastern Shore may have much higher traffic volumes on a summer weekend day than on a typical weekday peak period. Additionally, these high traffic volumes typically occur every weekend throughout the summer, rather than just around the holidays. To evaluate the summer weekend day, the study team used data from the IBNM, but adapted it for this study using the results of the 2002 Origin-Destination Study Report.

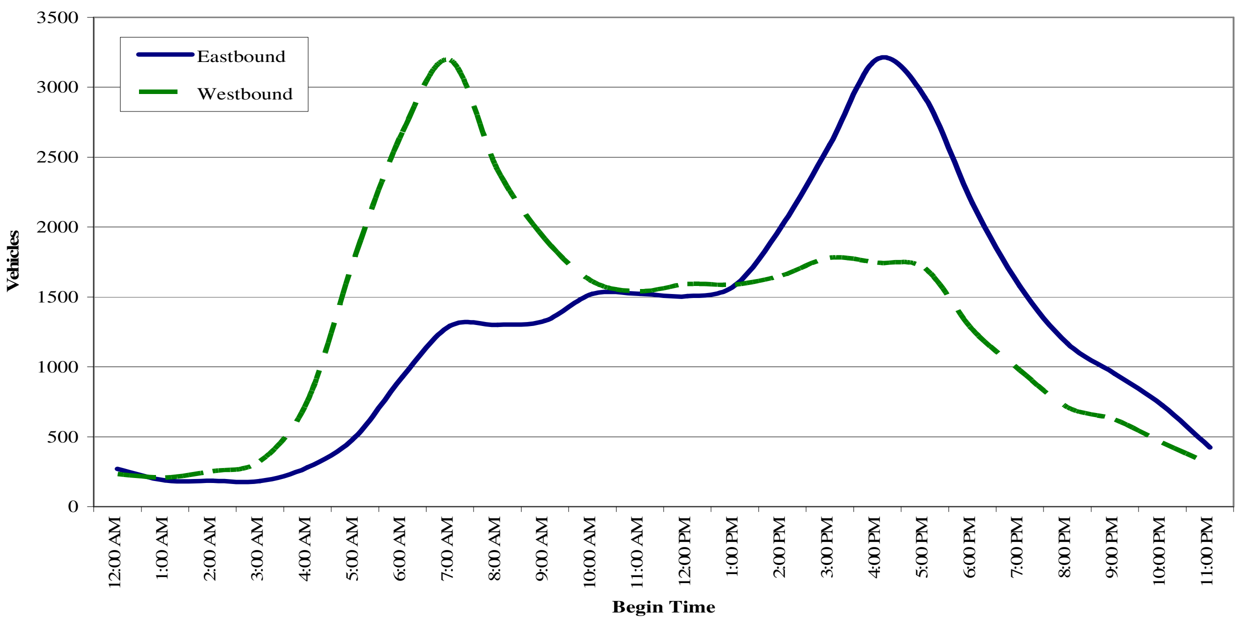
For the purposes of this transit study, only trips crossing the Bay Bridge were considered. While it is likely that travelers who live in communities on the western side of the Bay Bridge and beyond could use portions of the instituted network (i.e., if a transit route carries riders from Kent Island to Washington, DC with a stops in Annapolis and Bowie, additional riders could board at those stops to travel to DC), the study team did not consider these trips because they are not related to how many people would choose transit over the automobile to cross the Chesapeake Bay. In a detailed study of transit alternatives, these trips would be considered to understand the cost effectiveness of an entire transit system. For the purposes of analyzing the ability of transit to reduce traffic demands on the Bay Bridge, however, the trips from the model that represent boardings west of the Bay Bridge were not included in the analysis. In addition, truck trips, which typically transport goods and supplies, were assumed not to be able to use transit. Therefore, truck trips were removed from the trip data in the model and only non-truck trips are reported herein.

Potential Transit Routes

Non-Summer Weekday

The AM peak period, during which most people are traveling to work and the PM peak period, during which most people are returning home from work generally have the highest density of trips. These two travel periods will likely have the most congestion on the Bay Bridge and its approach roadways and the highest number of people using transit if transit service was provided. Because most people who journey to work during the AM peak period return home via a reversed route in the PM peak period, the study team studied only the AM peak period. The typical travel trends across the Bay Bridge on a non-summer weekday (existing conditions) are shown graphically, for conceptualization purposes, in **Figure 1**.

Figure 1
Typical Trends for Traffic Volumes on the Bay Bridge on a Non-Summer Weekday (Existing Conditions)



Trips across the Bay Bridge on a typical weekday may begin from a variety of places and may end at a variety of places, and not all of those beginning and ending points could easily be served by transit. In many cases, travelers who would prefer to take transit across the Bay Bridge, but whose origins are not served by transit, may be able to travel part of the way to the bridge (i.e. to a park and ride lot on Kent Island) and then continue their trip to their destination via transit. The study team assumed, for the purposes of analysis, that all transit trips originating on the Eastern Shore would board a transit system from a location on Kent Island near the Bay Bridge approach span. This assumption served to maximize the ridership projections for the potential transit routes, and therefore the focus of the technical studies was on the destination data.

Although both westbound and eastbound trips were analyzed in this study to determine if transit would be viable in both directions, the primary direction of travel during the AM peak period is the westbound direction. Therefore, only the results of the analysis of westbound weekday traffic are included in this report.

The first step in the process of developing existing and future potential transit trip data was to develop trip tables for person trip origins and destinations during the AM peak period (6:00 to 9:00 AM) for both existing and future (2030) conditions during a weekday using the IBNM. The results are summarized in **Table 1**.

Table 1
All Non-Truck Person Trips Crossing the Bay Bridge
During the Weekday AM Peak Period (6:00 – 9:00 AM)

Direction	Condition	Vehicle Trips	Person Trips
Eastbound	Existing	2,890	4,045
Westbound	Existing	6,980	9,775
Eastbound	Future (2030)	5,380	7,530
Westbound	Future (2030)	11,830	16,560

Next, the densities of person trips with either an origin or destination in each TAZ, as summarized in **Table 1**, were plotted to graphically illustrate how many trips originated or were destined to each TAZ. **Figure 2** shows the projected 2030 westbound AM peak period person trips across the Chesapeake Bay (a plot of existing data would show similar trends)**.** Analysis of this data shows that the majority of the trips originate from Kent Island and other portions of Queen Anne's County, and from Talbot and Caroline Counties. These trips are destined primarily for Baltimore, Washington DC, Anne Arundel County (specifically the Broadneck Peninsula and Annapolis), and BWI, Fort Meade, and the Bowie area. It is important to note that on **Figure 2**, neither Baltimore City nor Washington, DC show up as high trip density areas because the model is broken up into numerous TAZs within each city, and each TAZ is shown individually, not as one TAZ for the whole city. However, Baltimore City and Washington DC have mature interconnected transit service to help "distribute" transit patrons to the TAZs that have been grouped.

Maryland Transportation Authority

Analysis of Transit Only Concepts To Address Traffic Capacity Across the Chesapeake Bay

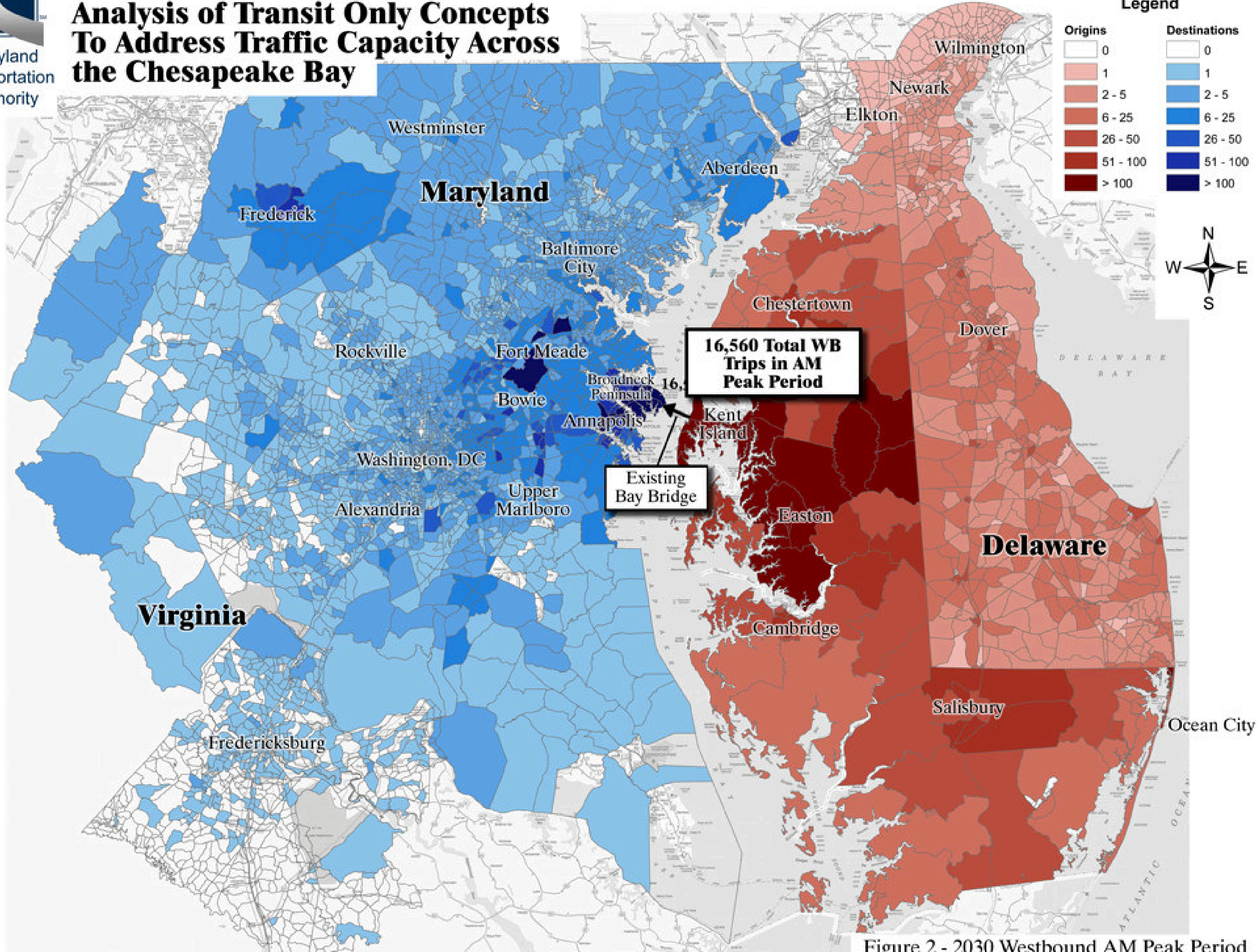


Figure 2 - 2030 Westbound AM Peak Period Person Trips by Traffic Analysis Zone
September 28, 2007

The results of this analysis show that trips crossing the Bay Bridge during the AM peak period on a weekday have a wide variety of potential origins and destinations. To narrow down the areas that could best be served by a transit-only concept, the study team identified the specific TAZs, or groups of TAZs, that had the highest densities of trips.

Based on an analysis of population densities, land uses, and existing transit capabilities throughout the region, seven groups of TAZs were identified as activity centers that could be served by the potential transit routes. These activity centers are shown in **Figure 3** and listed in **Table 2**, along with the person trips destined to each activity center.

The data listed in **Table 2** represents the total number of person trips traveling or projected to travel during the AM peak period of a weekday that *could* use transit to cross the Bay Bridge in the westbound direction if they choose to do so. The transit routes themselves would likely have a logical terminus near the Eastern Shore bridge approaches, cross the Bay Bridge, stop in Annapolis, and then split into two routes that would serve Baltimore and Washington, DC. These potential routes are shown on **Figure 2**. The portion of the total trips are shown in **Figure 2** represent almost 62 percent of the total trips (including trucks) crossing the Bay Bridge.

Table 2
Westbound Person Trips with Destinations That Could be Served by Transit
Non-Summer Weekday AM Peak Period (6:00 – 9:00 AM)

Westbound Destinations	Existing Person Trips	Future (2030) Person Trips
Broadneck Peninsula	1,860	2,225
Annapolis & Vicinity	2,275	3,665
BWI & Fort Meade	180	435
Bowie & Vicinity	370	645
Upper Marlboro	50	65
Baltimore City	860	915
Washington, DC & Vicinity	1,200	2,255
Total	**6,795**	**10,205**

Summer Weekend Day

As with the non-summer weekday analysis, the study team first evaluated the existing and future trip patterns to understand where travelers come from and where they are destined to. The method used for the summer weekend day analysis was similar to that used for the weekday analysis, but data from the IBNM had to be adapted to study weekend traffic because, as noted earlier, the IBNM does not include weekend data. The study team used results from the Authority's 2002 Origin-Destination Study Report, which were aggregated by districts

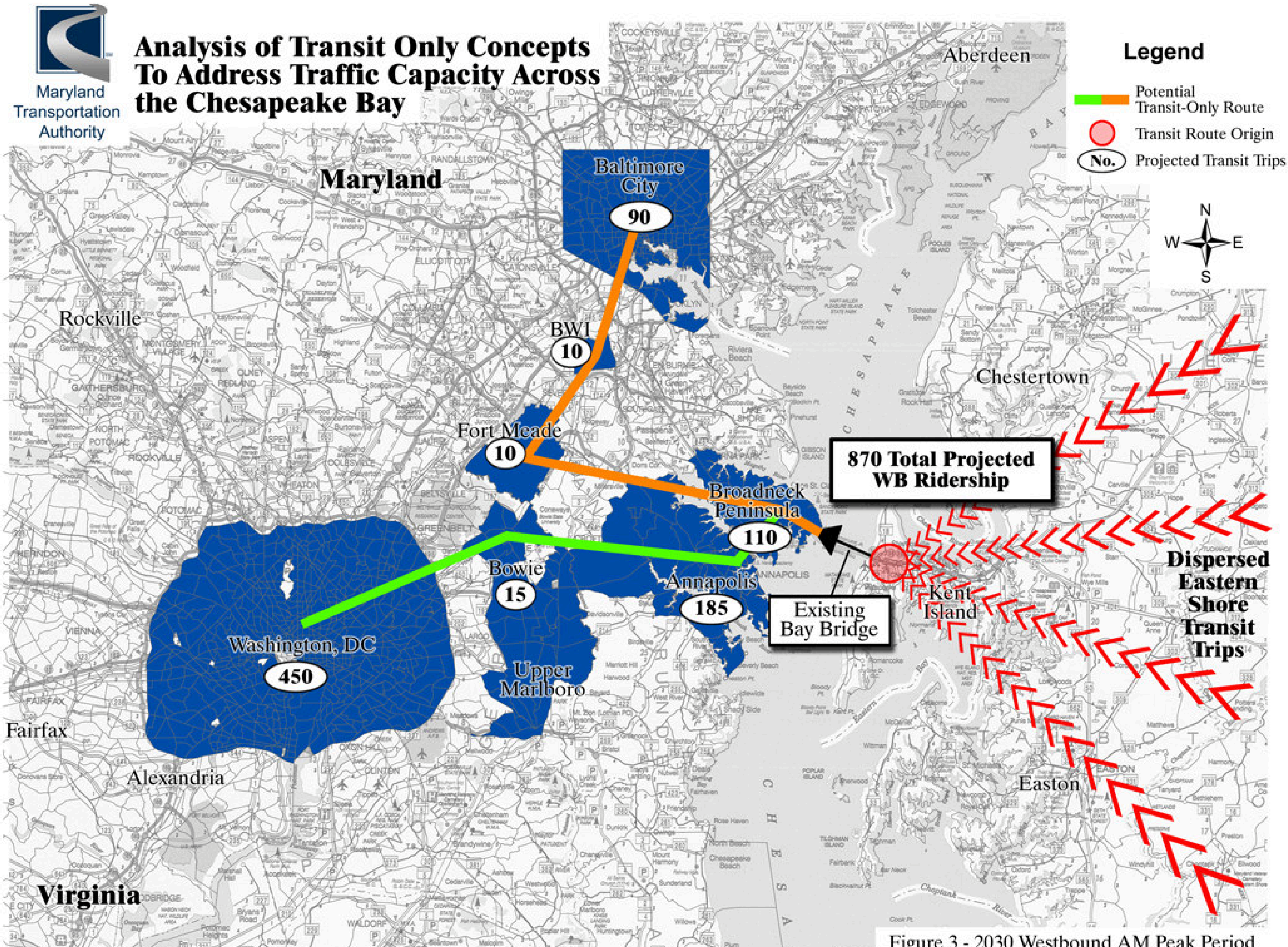
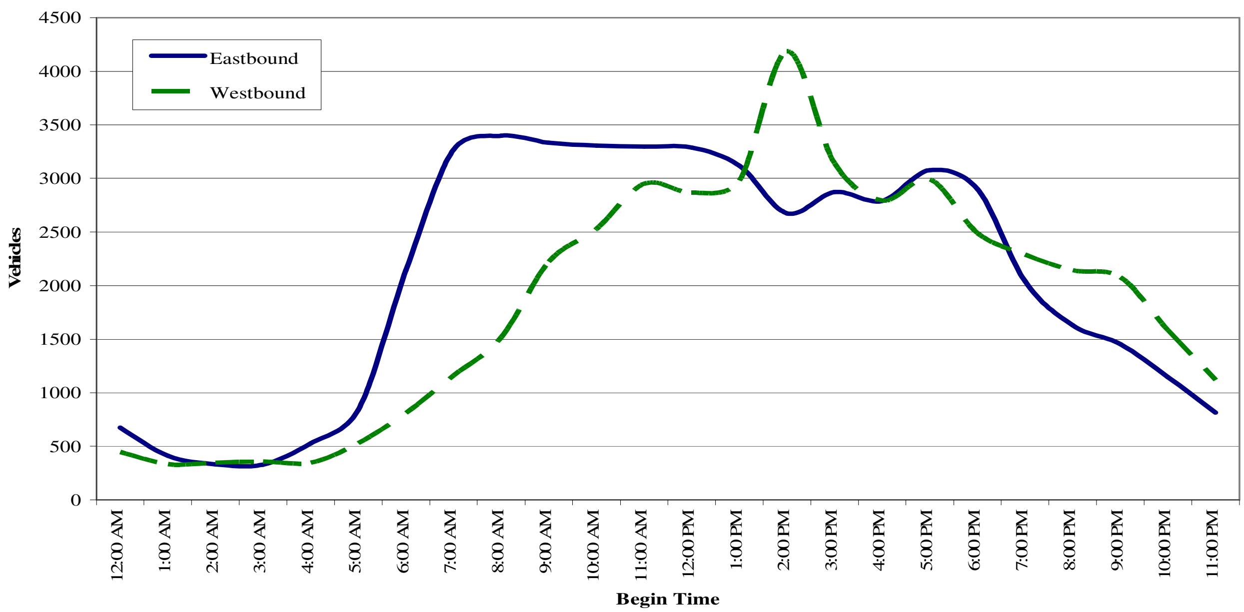


Figure 3 - 2030 Westbound AM Peak Period Projected Ridership
September 28, 2007

(composites of the TAZs in the IBNM) to understand how many of the recorded trips had an origin or a destination in each district, during both the weekday and the summer weekend day.

Next, data from the Origin-Destination Study was used to develop conversion factors applied for the IBNM weekday trip tables to compute estimated summer weekend day trip tables. The data was then expanded to represent the full day directional traffic volume recorded for a weekend day. Unlike during the weekday, the Bay Bridge does not experience defined peaks in traffic volumes on a summer weekend day. Rather, high traffic volumes are typically spread more uniformly throughout the day. It is therefore more useful to assess the Average Daily Traffic (ADT) volumes for the summer weekend day. Typical travel trends across the Bridge on a summer Saturday are shown graphically, for conceptualization purposes, in **Figure 4**.

Figure 4
Typical Trends for Traffic Volumes on the Bay Bridge on a Summer Saturday (Existing Conditions)



As for the non-summer weekday analysis, the destinations were the primary focus of this analysis. Because the Origin-Destination travel surveys used to develop the summer weekend day trip tables were only conducted in the eastbound direction, these analyses could only be applied to the eastbound direction. Based on available data, it was assumed that on a summer Saturday, the eastbound direction would be the primary direction of travel, and that a reverse trip pattern would occur in the westbound direction on a summer Sunday.

The IBNM was used to develop existing and future transit ridership trip tables for person trip origins and destinations during the full day for the eastbound direction of travel across the Bay Bridge, for existing and future (2030) conditions during a summer weekend. The total number of existing and future (2030) vehicle and person trips for a summer Saturday are summarized in **Table 3**. The number of trips shown below does not include truck trips.

Table 3
All Non-Truck Trips Using the Bay Bridge During a Summer Saturday (24-Hour Period)

Condition	Vehicle Trips	Person Trips
Existing	47,600	109,480
Future (2030)	91,200	209,760

As for the weekday, following development of the trip table, the study team plotted the trip data to illustrate the density of person trips with either an origin or destination in each TAZ. This information is presented in **Figure 5** for future (2030) conditions (existing and 2030 conditions show very similar travel patterns).

Figure 5 shows that the highest densities of trips are coming from Prince George's and Anne Arundel Counties, although many of the trips originate from all over Central and Southern Maryland, as well as Washington, DC and Virginia. The destinations for these trips are widespread across the Maryland Eastern Shore and Delaware with high densities of trips in Queen Anne's, Talbot, and Caroline Counties, as well as in Wicomico and Worcester Counties. Kent and Dorchester Counties are also expected to receive a significant number of trips. The sizes of the TAZs on the Maryland Eastern Shore may, however, create the illusion that a high density of trips are destined for those locations when, in fact, the destinations may be rather spread out.

Figure 5 also shows that trips crossing the Bay Bridge during a summer weekend day have a wide variety of possible origins and destinations. The study team therefore identified specific TAZs, or groups of TAZs, that would likely provide transit service for the largest number of people along a reasonably direct route.

Based upon analysis of the trip tables and detailed consideration of population densities, land uses, and existing transit capabilities throughout the region, five destination activity centers were identified that could be served by the potential transit routes. As for the weekday analysis, the study team assumed that all potential transit riders originating from west of the Bay Bridge would travel by auto to reach the terminus of the transit line and then travel east across the Bay Bridge to one of these activity centers. The destination activity centers are shown in **Figure 6** and listed in **Table 4,** along with person trips destined to each of these activity centers.

Maryland Transportation Authority

Analysis of Transit Only Concepts To Address Traffic Capacity Across the Chesapeake Bay

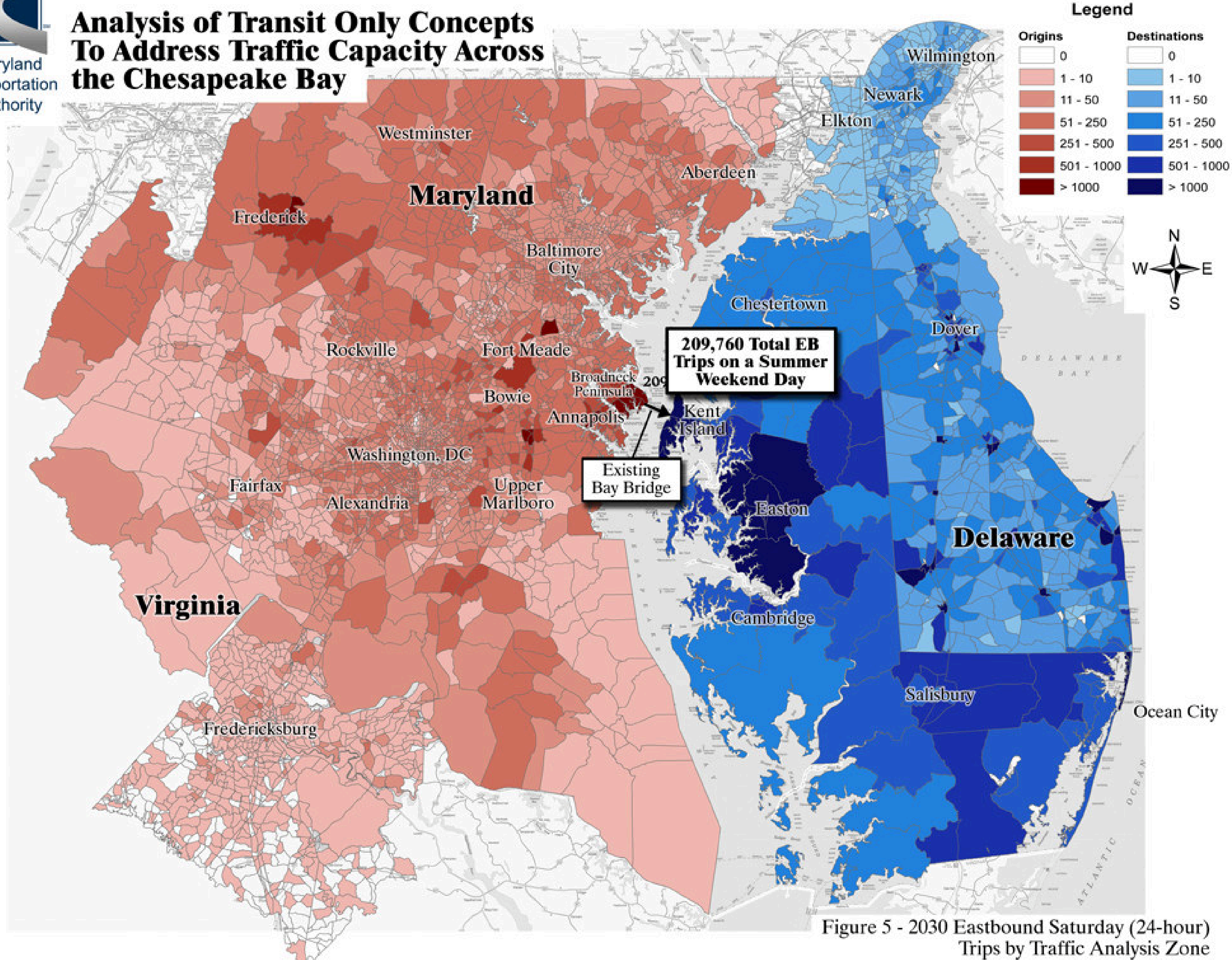
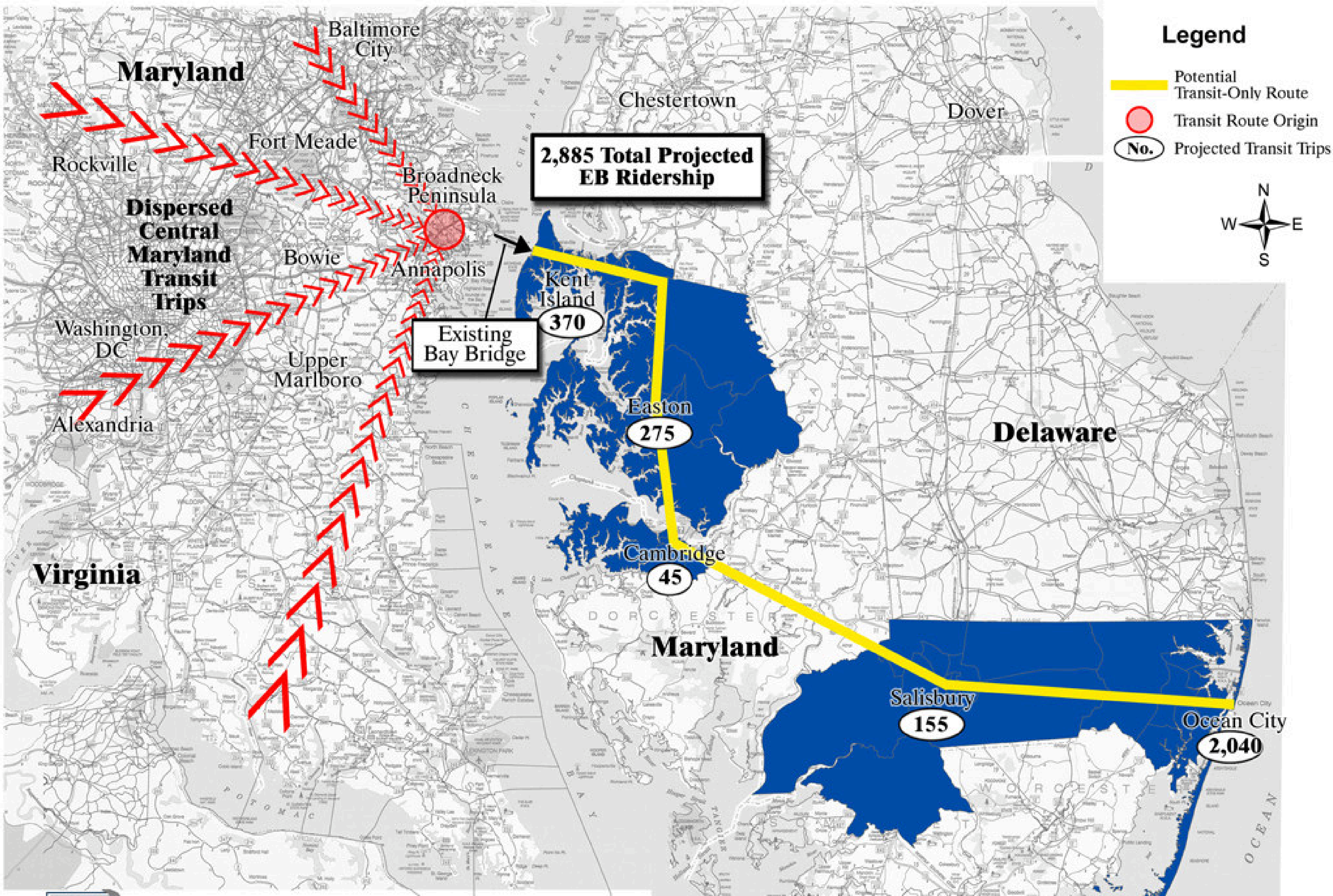


Figure 5 - 2030 Eastbound Saturday (24-hour) Trips by Traffic Analysis Zone

September 28, 2007



Maryland Transportation Authority

Analysis of Transit Only Concepts To Address Traffic Capacity Across the Chesapeake Bay

Figure 6 - 2030 Eastbound Saturday (24-hour) Projected Ridership
September 28, 2007

Table 4
Potential Eastbound Transit Trips
Summer Saturday (24-Hour Period)

Eastbound Destinations	Existing Person Trips	Future (2030) Person Trips
Kent Island & Vicinity	16,595	18,380
Easton & Vicinity	9,650	13,815
Cambridge	1,105	2,265
Salisbury & Vicinity	3,555	7,735
Ocean City & Vicinity	25,105	40,835
Total	**56,010**	**83,030**

The person trips listed in **Table 4** represent the total number of people that could use transit to cross the Bay Bridge on a summer weekend day if they chose to do so. As noted above, it was assumed for the purposes of analysis that travelers that would use an eastbound transit system would travel to a station near Annapolis and board a train or bus there. A transit route that serves the highest density destinations on the Eastern Shore was assumed to originate near Annapolis and cross the Bay Bridge and have stops at Kent Island, Easton, Cambridge, Salisbury, and Ocean City. This potential route is depicted on **Figure 6**. Again, while these trips represent only a portion of the total traffic crossing the Bay Bridge, approximately 40 percent of all future (2030) eastbound trips are destined to the five activity centers listed in **Table 4**.

Analysis of Potential Transit Ridership

The next step in the study was to project the number of riders who likely would use transit to reach the activity centers identified for the westbound (weekday) and eastbound (summer weekend day). Both the existing conditions and future (2030) conditions were evaluated.

Weekday

The analysis of potential transit routes using data from the IBNM resulted in potential transit routes that would serve westbound commuter trips from Kent Island and other portions of Queen Anne's County, Talbot and Caroline Counties that are destined to the Broadneck Peninsula and Annapolis, BWI, Fort Meade, the Bowie area, Baltimore City, and Washington, DC. These routes were selected because they could serve activity centers determined to have the highest density of traveler destinations. However, not everyone destined for these activity centers will choose to or can use transit, or would use it every day.

Therefore, the study team used data from the BMC Model, the Journey to Work portion of the 2000 Census, and information collected from the travel surveys at the Bay and Nice Bridges to assess the potential ridership and the percentage of travelers who would use transit (usually a wide range for most metropolitan areas) rather than drive. The study team also reviewed existing ridership data for Baltimore City and Washington, DC, regions where transit service currently exists. Using this data, and information specific to each of the destination activity centers listed in **Table 2**, the study team estimated the percent of transit ridership compared to total trips from the model, or ridership factor. The percentage of travelers that would switch to transit service, if available, depends on many factors, including how close the stops are to their origin and destination points and the transit connections at their destination.

The percentage of transit ridership for trips destined to Washington, DC was determined to be approximately 20 percent of total trips for a weekday. Because of Washington, DC's high density, the relatively high cost and limited availability of parking, and the mature interconnected transit system the likelihood of someone using transit to get to Washington, DC is relatively high compared with other locations in the region.

The percentage of transit ridership for trips destined to Baltimore City was determined to be approximately 10 percent for a weekday. Baltimore City, which boasts good transit service, but which also has more moderately priced and available parking, demonstrates a slightly lower likelihood of transit usage for travelers destined there.

Relatively dense areas (where density is based on land use, trip densities, or both) in Central Maryland, such as Annapolis, Broadneck Peninsula, Fort Meade, and BWI were estimated to have a transit ridership of approximately five percent while less dense areas of Central Maryland, such as Bowie and Upper Marlboro, were estimated to have a transit ridership of approximately two percent.

The study team applied the transit ridership factors to the data compiled in **Table 2** and found that for existing conditions, approximately 5.6 percent of all westbound person trips would likely use transit during the AM peak period. For future (2030) conditions, approximately 5.3 percent of all westbound person trips would likely use transit during the AM peak period. The results of this analysis are presented in **Table 5**. These results indicate that a relatively small number of travelers crossing the Bay Bridge and destined for the activity centers with the highest trip destination density would likely use transit, both under existing conditions (550 transit riders) and in 2030 (870 transit riders). Please also refer to **Figure 3** which shows the total projected ridership to activity centers on the Western Shore.

Weekend Day

Traditionally, heavy rail, light rail, and BRT serves commuter traffic during the week and it is difficult to predict how successful a fixed guideway transit service would be to the Eastern Shore. For example, Ocean City is a popular destination with relatively dense land use, available parking, and a good existing bus system. Many factors could contribute to the decision of beach travelers to switch to transit: the long trip along congested roads to Ocean City; the need to travel with children, luggage, or items for the beach; and available modes of transportation once they reach the shore. Some travelers may be daily or weekend-only travelers who could choose to use transit to reach the shore and rely on bus service during their short stay.

Table 5
Estimated Westbound Transit Trips
Weekday AM Peak Period (6:00 – 9:00 AM)

Westbound Destinations	Ridership Factor	Total Existing Person Trips	Existing Transit Person Trips	Total Future (2030) Person Trips	Future (2030) Transit Person Trips
Broadneck Peninsula	5 %	1,860	90	2,225	110
Annapolis & Vicinity	5 %	2,275	115	3,665	185
BWI & Fort Meade	5 %	180	10	435	20
Bowie & Vicinity	2 %	370	10	645	15
Upper Marlboro	2 %	50	0	65	0
Baltimore City	10 %	860	85	915	90
Washington, DC & Vicinity	20 %	1,200	240	2,255	450
Total		**6,795**	**550**	**10,205**	**870**

After considering all of these factors, and comparing the nature of Ocean City on a summer weekend day with Central Maryland destinations on a weekday, the study team determined that a reasonable transit ridership percentage for trips to Ocean City is approximately five percent. The remaining transit destinations on the Eastern Shore, presented in **Table 4** and in **Table 6** below, are somewhat more spread out, and have somewhat fewer trips destined to them. As such, it was determined that for a summer weekend day, a reasonable transit ridership percentage for trips to these Eastern Shore destinations is approximately two percent.

The results of this analysis are presented in **Table 6**. These results indicate that compared to a weekday, more travelers crossing the Bay Bridge and destined for the Eastern Shore locations with the highest trip densities would likely use transit, both under existing conditions (1,870 transit riders) and in 2030 (2,885 transit riders). This equates to approximately 1.7 percent of all eastbound person trips for existing conditions and 1.4 percent of all eastbound person trips in 2030. Please also refer to **Figure 6** which shows the total projected ridership to activity centers on the Eastern Shore.

Table 6
Estimated Eastbound Transit Trips
Summer Weekend Day (24-Hour Period)

Eastbound Destinations	Ridership Factor	Total Existing Person Trips	Existing Transit Person Trips	Total Future (2030) Person Trips	Future (2030) Transit Person Trips
Kent Island & Vicinity	2 %	16,595	330	18,380	370
Easton & Vicinity	2 %	9,650	195	13,815	275
Cambridge	2 %	1,105	20	2,265	45
Salisbury & Vicinity	2 %	3,555	70	7,735	155
Ocean City & Vicinity	5 %	25,105	1,255	40,835	2,040
Total		**56,010**	**1,870**	**83,030**	**2,885**

Industry-Wide Ridership Thresholds

For the purposes of this study, the only types of transit considered were those that run on a fixed guideway or within a dedicated right-of-way, such as HRT, LRT, or BRT. Heavy rail is the traditional rail technology that includes high speed, commuter regional travel, subways and freight. Travel is faster but the number of destinations and stops is limited to achieve the high speeds. The higher speeds and the shared use of the railways (with other operators) require stricter standards for rail construction and transit cars and greater initial construction costs. Light rail is sometimes described as the modern version of the street car. Whereas light rail is constrained by lower speeds for shorter distances, it is flexible in design, engineering and operations. It was developed to be a cost-effective intra-city alternative to regional rail. BRT is an emerging transit choice that includes a dedicated lane for buses only and can accommodate express bus service. Each of the three types of transit attracts different types of trips, which results in different levels of ridership. Heavy rail generally serves larger regions with the least flexibility, while BRT service is most flexible in terms of locations and schedules.

As a general rule of thumb, minimum thresholds for transit ridership have been estimated 4,000 to 5,000 passengers per line mile for a flexible Bus Rapid Transit system, mainly at-grade or operating within a roadway or roadway-type right-of-way; 7,000 to 8,000 passengers per line mile for a typical LRT line; and 13,000 to 15,000 passengers per line mile for a fully grade separated transitway. (Public Transportation and Land Use Policy, Pushkarev et al., 1977).

To further illustrate how transit-only options across the Bay compare to existing transit service, the study team has compiled statistics on daily transit use for the HRT, LRT, and commuter bus services in Maryland. The HRT service in Maryland includes the MARC system and the Baltimore Metro. The MARC System consists of the Brunswick Line, between Frederick County and Martinsburg, West Virginia; the Penn Line, between Perryville and downtown Baltimore and Washington, DC; and the Camden Line, between Downtown Baltimore and Washington, DC). This commuter rail service operates on existing track and is shared with freight and AMTRAK passenger rail trains. The MARC lines have a total of 42 stops in Maryland and terminate at Martinsburg, West Virginia. Commuters can access the MARC service via Park and Ride lots operated by the Maryland Transit Administration and independently operated lots. During the morning commute, the most popular park and ride lots are Odenton, West Baltimore and Point of Rocks, in Frederick County. The most recent data in 2007 for Average Daily Ridership of the MARC lines was 18,123 for the Penn Line, 6,629 for the Brunswick Line, and 4,222 for the Camden Line.

The original Baltimore Metro line opened in 1987 with three stations and extended to the Johns Hopkins Medical Center in 1995. The Baltimore Metro line serves 14 stations along its 14.7 mile route. The most recent data for 2007 shows the Average Daily Ridership of the Baltimore Metro was 44,080.

In Baltimore, LRT service extends north to the Hunt Valley commercial area and south to Glen Burnie and the BWI Thurgood Marshall Airport, for a total length of 28.8 miles. Light rail operates seven days a week, including holidays. Ridership in 2002 and 2003 remained consistent, around 29,000 riders per day. Ridership data for 2004-2006 is available but is not representative of the typical ridership due to the construction of double tracking that took place during that period.

In addition, the MTA provides commuter bus service from Kent Island to Washington, DC with one stop at Harry S. Truman Parkway, located on the outskirts of downtown Annapolis. Eight buses each day cross the Bay Bridge to serve the 150 and 200 passengers per day. The park and ride lot from which this bus departs on Kent Island has about 265 spaces. The MTA provided bus service from Kent Island to Baltimore City in the past, but this service was dropped in February 2005.

The MTA is also studying major new transit projects in Maryland (including the Purple Line in suburban Washington DC, and the Green and Red lines in Baltimore) and these projects also provide information on expected ridership. The Corridor Cities Transitway is another planning project that includes a transit component (LRT, BRT or premium bus service) on a proposed HOV lane. The study found that the BRT alternate is projected to carry about 89,200 daily transit trips for which 30 minutes of travel time savings would be realized and the Premium Bus alternate would serve 53,400 transit trips that would save 30 minutes of travel time. The LRT alternate would support the same number of transit trips as the BRT alternate but with less travel time savings. In Virginia, the Dulles Corridor Metrorail Phase I and II projects are projected to serve daily riderships of 62,800 and 83,200, respectively. Each phase will consist of an 11.5-mile-long (approximate) HRT line. Phase I will connect from the Orange Line at Falls Church to

Wiehle Avenue and Phase II will connect from Wiehle Avenue to Dulles Airport and the Route 772 Extension.

As shown in **Table 5** and **Table 6** , the projected future (2030) westbound transit ridership would be 870 person trips for a non-summer weekday (peak period) and 2,885 person trips for a summer Saturday (24-hour period) in one direction. The round-trip ridership for a non-summer weekday would be roughly double the peak ridership, or 1,740. For a summer weekend day, it is likely that those who travel to the Eastern Shore would return on a different day of the week. The projected ridership falls well below that for any fixed-guideway recently constructed in the U.S. Although these projections are significantly lower than the minimum thresholds, they do not include any person trips that might be added to the transit line once it crosses the Bay Bridge. If these trips were considered, it is possible that the projected ridership would increase. As noted above, the MTA currently offers transit service between Kent Island and Washington D.C., yet ridership on that service, including boardings in Western Shore activity centers (i.e., Annapolis, Parole, Bowie, etc.), does not appear to significantly narrow the gap between the minimum thresholds and the modeled ridership for this service.

LEVEL OF TRAFFIC RELIEF AT THE BAY BRIDGE DUE TO TRANSIT

The next question that the study team set out to answer was whether the potential transit routes could afford some level of traffic relief on the existing Bay Bridge, both under existing and future conditions for a weekday and a summer weekend day. The second component of this study was therefore to assess the possible benefit that removing these trips from the Bay Bridge could have on its operations. Thus far, the analyses have focused on the non-truck trips, since those trips are the only trips likely to switch to transit. For the capacity analysis, however, all vehicle trips, including truck trips, were considered because all of these trips contribute to the congestion on the Bay Bridge.

Non-Summer Weekday

To perform a capacity analysis of traffic on the Bay Bridge, the weekday person trips were converted back to vehicle trips. As mentioned previously the data from the IBNM indicates that 1.4 person trips are equivalent to one vehicle trip.

For this component of the study, capacity analyses for both peak periods were performed, with the assumption that all transit trips made during the AM peak period would make their return trips during the PM peak period. As previously discussed, it is anticipated that the AM and PM peak periods would experience similar, although reversed, traffic patterns, so the routes developed using one peak period should be reversed during the other peak period. However, while the overall trip patterns are expected to be similar, the volume of traffic occurring in the PM peak period could be somewhat different from the traffic volumes experienced in the AM peak period.

The study team performed capacity analyses for the existing and future (2030) conditions considering the effect of the transit service. Levels of service (LOS) for travel on the Bay Bridge during the AM and PM peak periods were developed using methods adopted from the Highway Capacity Manual 2000 (HCM). The LOS used in the assessment of conditions on the Bay Bridge during both existing and future (2030) conditions on a weekday are presented in **Table 7**. The traffic operations were analyzed for both the standard and contra-flow conditions in the eastbound and westbound directions. Contra-flow operation involves closing one lane on the westbound span of the Bay Bridge to westbound traffic and opening that lane to eastbound traffic thereby creating two westbound lanes and three eastbound lanes. Operation of contra-flow lanes occurs at some point each day.

Table 7
Peak Period (6:00-9:00 AM and 4:00-7:00 PM)
Levels of Service Thresholds for the Bay Bridge

LOS	Eastbound Traffic Standard Operation (2 Lanes)	Eastbound Traffic Contra-Flow Operation (3 Lanes)	Westbound Traffic Standard Operation (3 Lanes)
A ≤	2,775	3,415	3,915
B ≤	4,540	5,590	6,405
C ≤	6,520	8,025	9,200
D ≤	8,110	9,985	11,445
E ≤	9,120	11,230	12,870
F >	9,120	11,230	12,870

The peak period capacity of the Bay Bridge was determined based on the capacity data provided by the Authority during the Task Force process. For the eastbound direction the Authority determined the per-lane, per-hour capacity of the Bay Bridge to be 1,520 vehicles under standard (two-lane) operations and 1,248 under contra-flow (three-lane) operations. For the westbound direction, the per-lane, per-hour capacity was determined to be 1,290 vehicles under standard operations and 1,430 under contra-flow operations. The study team converted the hourly capacity to match the IBNM peak period output for the weekday. For the purposes of these analyses, the AM and PM peak periods are each three hours long. Therefore, the per-lane, per-hour capacities presented above were multiplied by three hours and by the number of lanes to develop estimated peak period capacities.

The results of the analysis for the weekday are shown in **Table 8** and include the projected reduction in vehicle trips and the estimated reduction in demand, respectively, for the westbound span of the Bay Bridge during the AM peak period. Examination of **Table 8** shows that under existing conditions, the westbound Bay Bridge would be expected to function at LOS C during the AM peak period whether or not transit service was provided. Similarly, although a transit-only route would be expected to somewhat reduce the demand on the westbound Bay Bridge under future (2030) conditions, the westbound span would be expected to function at LOS F with or without transit.

Table 8
Effect of Transit on the Bay Bridge
Westbound Trips – Non-Summer Weekday AM Peak Period (6:00 – 9:00 AM)

	Existing Vehicle Trips AM Peak Period	**Future (2030) Vehicle Trips AM Peak Period**
Capacity of the of the Bay Bridge (Westbound Direction – three lanes)	12,870	12,870
All Vehicle Trips (including trucks)	7,475	14,540
Percent of Bridge Capacity Used	**58%**	**113%**
Estimated Level of Service (LOS)	**C**	**F**
Estimated Transit Vehicle Trips	395	620
Percent Reduction in Vehicle Trips Due to Transit	5.3%	4.3%
Vehicle Trips after Transit Trips Removed	7,080	13,920
Percent of Bridge Capacity Used	**55%**	**108%**
Estimated Level of Service (LOS)	**C**	**F**

Table 9 presents the results of the same analyses for vehicle trips across the eastbound span under both standard and contra-flow operation during the PM peak period. Examination of **Table 9** shows that the eastbound Bay Bridge is currently operating at LOS E conditions during the PM peak period of a weekday (LOS D with contra-flow), and that conditions are expected to worsen to LOS F in the future. Even with the Bay Bridge operating under contra-flow conditions the Bridge would be over capacity with or without transit in 2030.

For the weekday, during both the AM and PM peak periods, and under both existing and future (2030) conditions, it is not anticipated that provision of transit service will provide a significant benefit to traffic conditions for vehicles flowing in either the eastbound or the westbound directions. While transit service would be expected to reduce vehicle volumes on the Bay Bridge, the reduction would likely be very small relative to the overall volume.

Table 9
Effect of Transit on the Bay Bridge
Eastbound Trips – Non-Summer Weekday PM Peak Period (4:00 – 7:00 PM)

	Standard Operation (Two Lanes)		**Contra-Flow Operations (Three Lanes)**	
	Existing Vehicle Trips	**Future (2030) Vehicle Trips**	**Existing Vehicle Trips**	**Future (2030) Vehicle Trips**
Capacity of the of the Bay Bridge (Eastbound Direction)	9,120	9,120	11,230	11,230
All Vehicle Trips (including trucks)	8,700	16,885	8,700	16,885
Percent of Bridge Capacity Used	**95%**	**185%**	**77%**	**150%**
Estimated Level of Service (LOS)	**E**	**F**	**D**	**F**
Estimated Transit Vehicle Trips	395	620	395	620
Percent Reduction in Vehicle Trips Due to Transit	4.5%	3.7%	4.5%	3.7%
Vehicle Trips after Transit Trips Removed	8,305	16,265	8,305	16,265
Percent of Bridge Capacity Used	**91%**	**178%**	**74%**	**145%**
Estimated Level of Service (LOS)	**E**	**F**	**D**	**F**

Summer Weekend Day

A similar capacity analysis was performed for the summer weekend day. As with the weekday, person trips were converted back to vehicle trips, based on the IBNM data that shows that 2.3 person trips is equivalent to one vehicle trip.

The LOS for travel on the Bay Bridge during the full day were also developed using methods adopted from the Highway Capacity Manual 2000 (HCM). The LOS used in the assessment of conditions on the Bay Bridge during both existing and future (2030) conditions on a summer weekend day are presented in **Table 10**. The full day capacity used in these analyses for the existing Bay Bridge is approximately 39,600 vehicles for two lanes in one direction (this data is based on per-lane ADT capacities presented to the Task Force in 2005). Note that a contra-flow lane as less capacity than a standard lane.

Table 10
ADT Levels of Service Thresholds for the Bay Bridge

LOS	Eastbound Traffic Standard Operation (Two Lanes)	Eastbound Traffic Contra-Flow Operation (Three Lanes)
A ≤	12,000	14,800
B ≤	20,400	25,100
C ≤	28,800	35,500
D ≤	36,000	44,300
E ≤	39,600	48,800
F >	39,600	48,800

The results of the capacity analyses are summarized in **Table 11** for the eastbound Bay Bridge on a summer Saturday.

Examination of **Table 11** shows that the eastbound Bay Bridge is currently operating at LOS F on a summer Saturday, and that conditions are expected to worsen dramatically in the future. Although provision of transit would be expected to reduce the demand on the eastbound Bay Bridge under future (2030) conditions by a small amount (1.1 percent), the eastbound span would be expected to function at LOS F with or without transit. Even with the operation of contra-flow lanes, the demand in the future (2030) would still exceed the capacity of the Bridge.

The 109,600 vehicles include only the daily volume in the eastbound direction. To compute the full day ADT, that is, the volume of traffic crossing the Bridge in both directions during an entire day, the study team applied a directional distribution factor of 60 percent (i.e., 60 percent of the traffic flows in the eastbound direction and 40 percent flows in the westbound direction). Applying this factor will result in a full day ADT volume of 182,700 in 2030. As noted previously, the IBNM is a more refined and detailed model than the sketch-level model that was used to predict the 2025 volumes published in the Bay Bridge Needs Report. In that report, the ADT was projected to be 135,000 in 2025.

Table 11
Effect of Transit on the Bay Bridge
Eastbound Trips –Summer Weekend Day (24-Hour Period)

	Standard Operation (Two Lanes)		**Contra-Flow Operation (Three Lanes)**	
	Existing Vehicle Trips	**Future (2030) Vehicle Trips**	**Existing Vehicle Trips**	**Future (2030) Vehicle Trips**
Capacity of the of the Bay Bridge (Eastbound Direction)	39,600	39,600	48,800	48,800
All Vehicle Trips (including trucks)	54,600	109,600	54,600	109,600
Percent of Bridge Capacity Used	**138%**	**277%**	**112%**	**225%**
Estimated Level of Service (LOS)	**F**	**F**	**F**	**F**
Estimated Transit Vehicle Trips	815	1,255	815	1,255
Percent Reduction in Vehicle Trips Due to Transit	1.5%	1.1%	1.5%	1.1%
Vehicle Trips after Transit Trips Removed	53,785	108,345	53,785	108,345
Percent of Bridge Capacity Used	**136%**	**274%**	**110%**	**222%**
Estimated Level of Service (LOS)	**F**	**F**	**F**	**F**

ANALYSIS OF THE COSTS OF THE POTENTIAL TRANSIT ROUTES AND MEASURES NEEDED TO SUPPORT TRANSIT

To understand the potential costs of constructing a new exclusive right-of-way transit system, the study team developed sketch level cost estimates for the potential routes. However, the construction of the transit system is not the only consideration involved in making transit a successful option. For example, certain levels and types of development are needed to sustain transit-only service and these measures would also come with certain costs. To understand these supporting measures, the study team researched previous studies of transit alternatives as well as existing transit systems to develop an estimate of land use densities that are needed to sustain transit service, both in terms of density and range. This research included identification of the current land uses in the area of the existing crossing and activity centers identified in this study and how those land uses are, or are not, consistent with accepted standards. While no costs were estimated for these supporting measures, understanding their place in the evaluation of a transit system serves to highlight the types of development that is expected to be in place.

The three types of transit (HRT, LRT, and BRT) have different infrastructure requirements and consequently varying ranges of construction, operating, and maintenance costs. When considering the complete lifecycle of the transit system, the cost of infrastructure for heavy rail may be offset by the need to buy more light rail cars to serve the same demand of heavy rail. The Urban Land Institute reported that BRT is capable of providing service similar to light rail but at lower cost and BRT can operate at speeds two to three times higher than light rail. Recent construction nationwide costs for BRT, on exclusive rights-of-way, ranged from $20 to $25 million per mile (construction cost only). Likewise, the average construction cost for at-grade light rail ranges from $45 to $60 million per mile. Recent construction costs for heavy rail range from $125 to $200 million per mile. The range of construction costs could be even wider considering constraints and unique environmental characteristics of the area where the system is being considered.

In addition, the study team researched transit projects in Maryland and the surrounding region to understand the actual construction costs for existing projects and the estimated construction costs for projects under study. These projects and their associated costs (which in some cases include costs beyond only construction costs) are presented in **Table 12.**

Table 12
Construction Costs for Existing and Planned Projects

Project & Status	Total Cost ($ Billion)	Distance (miles)	Cost/Mile ($ Million)
Constructed Projects			
Baltimore Light Rail (Opened 1992)	$0.4	22.5	$17.7
BWI/Penn Station Extension (Opened 1997)	$0.1	7.5	$14.1
Planned Projects			
Purple Line	$0.61 -$1.6	16	$38 -$100
Corridor Cities Transitway –LRT alternate (MTA)	$0.8	13.5	$58.9
Corridor Cities Transitway –BRT alternate (MTA)	$0.5	13.5	$36.6
Corridor Cities Transitway –Premium bus service using HOV lane alternate (MTA)	$0.3	13.5	$21
Dulles Corridor Metrorail Project Phase I, completed by 2011 – HRT (WMATA, 2006)	$2.1	11.6	$181
Dulles Corridor Metrorail Project Phase II, completed by 2015 – HRT (WMATA, 2006)	$2.1	11.5	$174

To account for the wide ranges of costs, the study team assumed the following cost per mile factors to estimate construction costs for the potential transit routes in this study:

- BRT: $22 million per mile
- LRT: $52 million per mile
- HRT: $175 million per mile.

These cost-per-mile estimates do not include costs for acquisition of right-of-way, new bridge construction, or operation and maintenance of the system, which could increase the costs substantially (for example, long-span bridge project costs can range from $600 to $900 million per mile). **Table 13** summarizes sketch level construction costs using the cost per mile estimates. Again, the costs in **Table 13** do not include any costs for new bridge construction, right-of-way, or operations and maintenance of the system.

Table 13
Construction (Only) Costs for Potential Transit Routes (2007 dollars)

Potential Route	No. Miles	HRT Cost $ billions	LRT Cost $ billions	BRT Cost $ billions
Kent Island to Washington, DC	59	$10.3	$3.1	$1.3
Kent Island to Annapolis	20	$3.5	$1.0	$0.4
Kent Island to Baltimore	59	$10.3	$3.1	$1.3
Baltimore to Ocean City	145	$25.4	$7.5	$3.2
Annapolis to Ocean City	118	$20.7	$6.1	$2.6
Washington, DC to Ocean City	168	$29.4	$8.7	$3.7

Funding of New Transit Systems

The competition for transit funding is very strong in the United States. In Maryland, there are areas of the State for which transit has been shown to be a viable solution, and funding for these projects is scarce. The major source of funding for new transit projects is the Federal Transit Administration's (FTA) New Starts program. This program provides funding for new, locally planned, fixed guideway transit systems that use separate right-of-way or rail line, including rapid rail, light rail, commuter rail, automated guideway transit, people movers and bus rapid transit (that has dedicated facilities). To qualify for New Starts funding, a project must have been developed through an alternatives analysis study; a major investment study, or multimodal corridor study that evaluates modal and alignment options to meet mobility needs. The purpose of the alternatives analysis is to document the benefits, costs, and impacts of alternative transportation investments developed to meet the purpose and need for a proposed improvement in the corridor. New Starts criteria are developed as part of the alternatives analysis. The New Starts project justification criteria include mobility improvements, environmental benefits, operating efficiencies, cost efficiencies, transit supportive land use and future patterns, and other factors. The FTA's project justification criteria, including how these factors are measured, is available on the FTA's website (www.fta.dot.gov/planning/newstarts). The FTA rates New Starts projects using the project justification criteria and local financial commitment criteria, to assure that a project is feasible. The criteria are refined through the planning and project development process. Although the analysis presented in this report is not a detailed alternatives analysis that would satisfy the New Starts process, it does show that a transit-only concept across the Bay Bridge would likely not qualify under the New Starts Program criteria.

Measures Needed to Support Transit

In addition to the construction of the transit system itself, there are other supporting measures that are needed to make transit successful. The success of a transit system can be defined in many ways, however, and developing goals at the outset of a major transit planning study is essential to measuring the success or effectiveness of the transit system. Although the scope of this transit study is to assess the viability, potential congestion relief, and cost effectiveness of a transit-only concept across the Chesapeake Bay, the study team has also researched the transit supportive land use measures that experts have proven are needed to make transit successful.

Recognizing the importance of land use in transit planning, the FTA requires New Starts project sponsors to submit information that describes the potential for existing and future local and regional land use to support the proposed capital transit investment. FTA reviews the supporting documentation and quantitative land use data prepared by local agencies to assess the existing land use, transit supportive land use plans and policies, and performance and impacts of policies associated with proposed New Starts projects.

One of the assumptions of this Bay Bridge Transit Study was that for the weekday, all transit would originate from a station near the Bay Bridge on Kent Island and that all Eastern Shore commuters would drive from their dispersed origins to reach this station. While this assumption was sufficient to develop travel demand model results that gave transit the best chance from a technical analysis perspective, it may not be practical to implement a transit system this way. One factor to consider would be parking at the station, which would need to be provided for all of the transit riders in an area that is already crowded and congested. Many commuters might be reluctant to transfer from their automobile to transit once they've completed the initial leg of their trip by auto. Therefore, a transit system that is attractive to commuters on the Eastern Shore would need to be accessible by auto, bicycle, or walking and have development potential to optimize ridership.

Transit Supportive Land Use

Traditionally, transit has been most successful, has had the most ridership, in areas that were built around transit service – densely developed older cities that have high-priced parking which discourages automobile use. Many studies promote new transit, tied with transportation infrastructure savings and economic development or transit oriented development (TOD). This type of development would need to be supported by the master plans for the Eastern Shore counties.

In Maryland, the Department of Transportation has built extensive transit infrastructure in Central Maryland and is promoting transit-oriented development to increase the number of riders and get a better return on this public investment. Examples of this investment include planned development around the Odenton MARC Station and the Owings Mills Metro Station. Maryland's goal is to surround stations with vibrant neighborhoods where people can live, work and shop or eat out, all within a safe and pleasant walk to trains, subways and buses. Integrating a variety of land uses around transit stations can improve the quality of life and access to jobs, stimulate community reinvestment, and boost property values (Source: www.mdot-realestate.org/tod).

Transit-oriented development targets the area within a 15-minute walk of a transit station, or up to a half-mile away. TOD varies in look and feel depending on its location. In a downtown business district, the development would be denser and more office-oriented than in a suburban neighborhood, which would consist of more commercial uses like shops, restaurants, and entertainment. Common features frequently found at TOD sites include:

- TOD is pedestrian-friendly. The development often sits within a connected grid of streets that is easy to navigate. Pedestrians are made to feel safe with wide sidewalks, well-marked crosswalks, good lighting and narrow streets to slow car traffic.

- Parking should be carefully managed. The goal is to limit the number of parking spaces and encourage shared parking between different land uses that need it at different times of day or at different times of the week. Offices, for example, typically need parking during weekdays, while retail and entertainment venues more likely need it evenings or on weekends.

- Transit-oriented development should have high-quality transit service that includes, wherever possible, access to buses and rail. Many Maryland neighborhoods in the Washington metro area, for example, link residents to Metro stations with Ride-On buses.

A sketch level metric that has been used since the 1970's to determine the suitability of an urban area for transit, and the likelihood of residents to opt for transit over their cars, is the residential density of an area. According to Pushkarev and Zupan (Public Transportation and Land Use Policy,1977):

Higher density of urban development acts both to restrain auto use and to encourage the use of public transit…Average figures from a number of urban areas in the United States suggest that: At densities between 1 and 7 dwellings per acre, transit use is minimal…A density of 7 dwellings per acre appears to be a threshold above which transit use increases sharply…At densities above 60 dwellings per acre, more than half the trips tend to be made by public transportation.

Existing and Future Land Use Patterns on the Eastern Shore

Clearly it is difficult to apply the transit supportive land use policies employed in very large cities with the cities and towns on the Eastern Shore. In addition, there is not sufficient data to measure the dwellings per unit for the activity centers identified on the Eastern Shore for this study. However, the study team was able to compile some qualitative data that helps to characterize the types of land uses that exist or are planned for the Eastern Shore.

For example, housing growth on the Eastern Shore is a primary contributing factor to growing commuter traffic on the Bay Bridge. According to the Maryland Department of

Planning, 42 percent of all Eastern to Western Shore commuters come from Queen Anne's County. Fifteen percent come from Cecil County, but most likely do not use the Bay Bridge. The remaining commuters, 43 percent, are coming from Kent, Caroline, Talbot and Dorchester Counties, areas where housing is comparatively more affordable than what is available on the Western Shore. These commuters are attracted to the large employment centers and clusters on the Western Shore, including:

- Aberdeen Proving Grounds / Edgewood Arsenal
- Baltimore (Johns Hopkins, ISG Steel, Social Security, Constellation Energy, University of MD Medical, Port of Baltimore)
- Anne Arundel County (BWI Airport, Fort Meade / NSA, Annapolis)
- Washington (Federal Facilities, I-270 Biotech Corridor)

Employment opportunities on the Western Shore are expected to increase dramatically with the BRAC program, which will add thousands of jobs at Aberdeen, Fort Meade and Bethesda.

In addition, the study team researched the comprehensive plans and economic development information for the Eastern Shore Counties, which are summarized below:

Kent County

Kent County is located roughly 65 miles from Baltimore and 75 miles from Washington, DC. Kent County is defined by its rural landscapes and historic towns and agricultural and maritime economies and offers unmatched opportunities for naturalists and sportsmen. The county is concerned about sprawl residential developments and strips of commercial development that is changing the character of the land. To maintain its unique rural character, Kent County encourages growth in and adjacent to existing towns. Kent County is actively preserving agricultural lands through Transfer of Development Rights (TDR). According to the Department of Business and Economic Development's 2006 "Brief Economic Facts," the County has roughly 710 businesses that employ 6,900 workers. The county's exports include corn, soybeans and milk. Washington College in Chestertown, is one of the oldest colleges in the Nation, and is one of the County's largest employers. Other major types of employment include medical and health services, food processing paving and road construction materials, and valve manufacturing. The County's business districts include Chestertown, the county seat; population 4,800 and Rock Hall; population 1,400 (2000 data).

Talbot County

Talbot County is located roughly 60 miles from Baltimore and seventy miles from the District of Columbia. Talbot County is concerned about increased eastbound summer traffic on US 50, especially through the City of Easton. The County supports well-planned land use and discourages strip development along County and State roadways. Sixty-four percent of the land in Talbot County is farmland. The County uses TDR to protect agricultural lands. Though pressure to develop land is increasing, the County encourages growth in Priority Funding Areas and away from its 600 miles of shoreline, which is within the Chesapeake Bay Critical Area. Talbot County has created a niche for environmental science and technology firms. According to The Department of Business and Economic Development's 2006 "Brief Economic Facts," the County has roughly 1,700 businesses that employ 17,000 workers. Easton, the County seat and commercial center has a population of 12,000 (year 2000 data). Easton has several prime industrial parks and a small airport. Easton's historic maritime setting attracts tourists from local metropolitan areas. Talbot County's other business districts include St. Michaels (population 1,200), which also supports maritime related tourism, and Trappe (population 1,200).

Queen Anne's County

Queen Anne's County is located 49 miles from Baltimore and 60 miles from Washington, DC. Much of the County is open space or agricultural, however low-density residential development is the largest and fastest growing land use that is slowly taking over agricultural land. New residential and industrial development is located close to the Bay Bridge and around the Centreville area and US 301 corridor. The Comprehensive plan includes goals to improve the existing roadway network. One third of future growth in the County is planned on Kent Island. According to The Department of Business and Economic Development's 2006 "Brief Economic Facts," the County has roughly 1,400 businesses that employ 11,000 workers. Its major types of employment include food processing, manufacturing, distribution, publishing and hospitality services. The area also supports recreational boating and fishing industries, and related tourism. County infrastructure development focuses on improvements to the telecommunications network in support of technology-based firms. Queen Anne's County business districts include Stevensville (population: 6,000), Chester (population: 3,700) and Centreville (population: 1,970). (Source: 2000 census data)

Dorchester County

Dorchester County is located approximately 75 miles from Baltimore and 87 miles from Washington, DC. Roughly 40 percent of Dorchester County is forest, 30 percent is agriculture and 25 percent is wetlands. Two percent of the County is residential and one percent is commercial residential. Residential and Commercial areas include Cambridge, East New Market, Hurlock, Church Creek and Vienna. The predominance of forest, wetlands and shoreline in Dorchester County fosters extensive wildlife, particularly waterfowl, which attracts related hunting tourism. The Dorchester County Comprehensive Plan focuses on transportation improvements in existing towns, which are the designated growth areas. According to The Department of Business and Economic Development's 2006 "Brief Economic Facts," the County has roughly 740 businesses that employ 10,000 workers. Its major types of employment include manufacturing (roughly 25 percent), service industries, tourism and agriculture. Dorchester County's business districts include the City of Cambridge (population 11,000 (2000 data) and Hurlock (population 1,900), each with State designated Enterprise Zones. These Enterprise Zones fostered the recent development of the Cambridge/Dorchester Technology and Business Park (113 acres) and the 247-acre Hurlock Industrial Park.

Wicomico County

Wicomico County is located 105 miles from Baltimore and 116 miles from Washington, DC. The County and shares its northern border with Delaware's southern border. The County attracts commercial and industrial business from Delaware, Virginia and adjacent Maryland Counties. Wicomico County has grown at a faster rate than the rate of growth statewide.

Though there is land available in designated growth areas, much of the growth in the past three decades have occurred on farmlands outside designated growth areas. The County Comprehensive Plan promotes growth that will not cause environmental degradation. The County wishes to protect agricultural lands and sensitive areas, those designated as rural, agricultural/resource and conservation. Wicomico County encourages preservation of these lands through TDR and the Purchase of Development Program (PDR). According to The Department of Business and Economic Development's 2006 "Brief Economic Facts," the County has roughly 2,600 businesses and employs 37,000 workers. Types of employment include power generation, manufacturing, marine industries and food processing. The County has two State Enterprise Zones; Salisbury (population 23,700) and Fruitland (population 3,800). The Salisbury Port is the second largest port in Maryland. A regional airport on the outskirts of Salisbury is served by US Airways Express.

Worcester County

Worcester County is located between Delaware and Virginia and is 123 miles from Baltimore and 134 miles from Washington, DC. Ocean City is a major economic generator in Maryland. Sixty percent of the County's employment is related to tourism. Ocean City has fully developed and is now redeveloping vacant warehouses and industrial sites into condominiums. The Comprehensive Plan seeks to protect existing natural resources through sustainable use and creating designated growth areas. Agricultural lands will be protected by Right-to-Farm laws, TDR and land preservation. Existing municipalities such as Berlin, Pocomoke City, Snow Hill and Ocean City are expected to be the areas of future growth. Infill development is expected in existing residential subdivisions on the outskirts of Ocean City and existing towns. The Comprehensive Plan supports development of traditional communities that reduce reliance on automobiles. According to The Department of Business and Economic Development's 2006 "Brief Economic Facts," the County has roughly 2,200 businesses that employ 21,000 workers. Major types of employment include tourism, retail and hospitality services, medical services and manufacturing. The County's primary business district is Ocean City (resident population 7,100). Other business districts include Berlin (population 3,500) and Pocomoke City (population 4,100); which have designated State Enterprise Zones, and Snow Hill (population 2,400).

Based on these statistics and the regional and national standards for transit supporting measures described above, it is clear that the Eastern Shore towns and communities do not match the traditional transit model for land use range and density. In fact, their comprehensive plans indicate that they do not want to grow in this fashion. In addition, these communities do not currently include TOD type growth in their master plans. Additional land use planning to incorporate these measures would be needed to support a new fixed guideway transit system to carry commuters from the Eastern Shore to job centers in Baltimore, Washington, DC, and points in between.

SUMMARY OF CONCLUSIONS

The results of the study indicate that transit service will not provide a significant benefit to summer weekend or peak period weekday traffic. Ridership projections are significantly lower than the minimum thresholds for HRT, LRT, or BRT. While transit service would reduce vehicle travel on the Bay Bridge, the reduction would likely be very small relative to the overall volume of traffic that uses the bridge. For example, on a summer weekend day, about eastbound 54,600 vehicle trips are made across the Bay Bridge and 109,600 eastbound vehicle trips are projected to be made in 2030 (which would exceed the capacity of the Bridge). Note that the full day summer weekend day volume in both directions is approximately 91,000 today and is projected to be 182,700 in 2030. On a summer weekend day, approximately 2,900 people would switch to transit by 2030, which equates to about 1,250 fewer cars on the bridge traveling to the Eastern Shore on a weekend day, or a 1.1 percent reduction in auto use. For weekday peak period traffic traveling westbound, approximately 870 people would switch to transit by 2030. This equates to about 620 fewer cars on the Bridge each morning traveling westbound, or a 4.3 percent reduction in auto use. In both cases, however, the traffic operations of the Bay Bridge are predicted to fail, with or without the transit-only route in place.

In addition, the land uses and population and employment densities would not support a fixed guideway transit service and these trends are not likely to change due to existing and planned land uses and population densities. Further, the estimated initial construction costs could be as high on the order of several billion dollars (not including construction of a new bridge to carry the transit service).

However, because transit is projected to attract ridership and provide some congestion relief at the existing Bay Bridge, it is clear that transit will be an important component of any future studies on additional capacity across the Chesapeake Bay.