

# Forecasting Short-term Ridership Activities (TBEST)



Final Report

September 4, 2007



**Gannett Fleming**

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<b>16. Abstract</b> <p>The Pennsylvania Department of Transportation (PennDOT) has initiated a pilot project to implement a new short-term transit planning model called TBEST (Transit Boardings Estimation and Simulation Tool). TBEST was developed by the Florida Department of Transportation's (FDOT) Public Transit Office (PTO) to provide support for Transit Agencies in developing their Transit Development Plans (TDP's). TBEST will be useful in this respect because it is capable of estimating transit ridership at the route stop-level and can then aggregate the ridership to the segment, route, and system levels.</p> <p>The TBEST pilot project for PennDOT entails the development of statewide socio-economic data which is compatible with TBEST, the development of the Endless Mountains Transportation Authority's (EMTA) and York County Transportation Authority's (RabbitTransit) TBEST networks, the calibration of each model, and the performance of the scenario based model analysis for both systems. This document explains the input data, process, and products used for the development of the Pennsylvania statewide socio-economic data and the development and coding of the EMTA and RabbitTransit TBEST networks.</p>			
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## Introduction

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The Pennsylvania Department of Transportation (PennDOT) has initiated a pilot project to implement a new short-term transit planning model called TBEST (Transit Boardings Estimation and Simulation Tool). TBEST was developed by the Florida Department of Transportation's (FDOT) Public Transit Office (PTO) to provide support for Transit Agencies in developing their Transit Development Plans (TDP's). TBEST will be useful in this respect because it is capable of estimating transit ridership at the route stop-level and can then aggregate the ridership to the segment, route, and system levels.

The TBEST pilot project for PennDOT entails the development of statewide socio-economic data which is compatible with TBEST, the development of the Endless Mountains Transportation Authority's (EMTA) and York County Transportation Authority's (RabbitTransit) TBEST networks, the calibration of each model, and the performance of the scenario based model analysis for both systems. This document explains the input data, process, and products used for the development of the Pennsylvania statewide socio-economic data and the development and coding of the EMTA and RabbitTransit TBEST networks.

## 1. Socio-Economic Data Development

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The background demographics used as the basic input for the TBEST model are derived from the publicly available Census and licensed InfoUSA spatial and tabular databases. The following sections describe the processes used for configuring these data sources for their use within TBEST.

### 1.1. Population

TBEST requires three file types from the Census information: SF1 and SF3 Census Attribute Tables and their corresponding Census Block-level polygon shapefiles. In support of the Pennsylvania implementation of TBEST, these Census files have been compiled from available sources for all counties in Pennsylvania and New York bordering counties. In order to use this data, the compiled Census information is available for download through a web-link in the TBEST software.

#### 1.1.1. Census Attribute Tables

Attribute data required for TBEST was downloaded directly from the US Census Bureau's web-site at <http://www2.census.gov/>. The 2000 Census data contains the full survey of results and data fields required by TBEST.

The Census SF1 summary data files were downloaded using the following web-link; [http://www2.census.gov/census\\_2000/datasets/Summary\\_File\\_1/](http://www2.census.gov/census_2000/datasets/Summary_File_1/). The required files for this dataset are 00001, 00002, 00037, and GEO. These files were also downloaded for the states of DE, MD, NJ, NY, OH, VA, and WV. The Census files were then moved into an Access database format using the process described on the Census Bureau website, <http://www.census.gov/support/SF1ASCII.html/>.

The Census SF3 summary data files were downloaded using the following web-link; [http://www2.census.gov/census\\_2000/datasets/Summary\\_File\\_3/](http://www2.census.gov/census_2000/datasets/Summary_File_3/). The required files for this dataset are 00001, 00002, 00003, 00006, 00007, 0056, 0058 and GEO. These files



were also downloaded for the states of DE, MD, NJ, NY, OH, VA, and WV. The Census files were then moved into an Access database format using the process described on the Census Bureau website, <http://www.census.gov/support/SF3ASCII.html/>.

Once the SF1 and SF3 datasets were assembled in Access, they had to be formatted for use within TBEST. In order to handle the processing of these large datasets, the processing was scripted using SQL Server. The stored procedures used are included as **Figure 1** and **Figure 2**. Due to time constraints and the requirements of the project, only the PA and NY Census information has been processed. The conversion mapping from the Census tables and fields to the TBEST required fields mapping and the SQL conversion queries used are listed below for both SF1 (**Table 1**) and SF3 (**Table 2**).

#### SQL Server SF1 Conversion Query

```
SELECT (CAST (dbo.SF1GEO.LOGRECNO AS INT)) AS ID,
        ((CAST (dbo.SF1GEO.AREALAND AS INT) +
        CAST (dbo.SF1GEO.AREAWATR AS INT)) * 10.763910417) AS AREA,,
        (CAST(dbo.SF1GEO.STATE AS INT))AS STATE,
        (dbo.SF1GEO.STATE + dbo.SF1GEO.COUNTY) as COUNTY,
        (CAST((CAST (dbo.SF1GEO.STATE AS NVARCHAR(2)) + CAST(dbo.SF1GEO.COUNTY
        AS NVARCHAR(3)) + CAST(dbo.SF1GEO.TRACT AS NVARCHAR(10))) AS BIGINT))
        as TRACT,
        (CAST (dbo.SF1GEO.BLKGRP AS INT))AS BLKGRP,
        CAST(dbo.SF1GEO.BLOCK AS INT) AS BLOCK,
        dbo.SF10001.P001001 as TOTPOP,
        dbo.SF10037.H001001 AS TOTHH,
        dbo.SF10001.P003004 as BLACK,
        dbo.SF10002.P008010 AS HISP,
        (dbo.SF10002.P012020 + dbo.SF10002.P012021 + dbo.SF10002.P012022 +
        dbo.SF10002.P012023 + dbo.SF10002.P012024 + dbo.SF10002.P012025) AS POP65,
        (dbo.SF10002.P012044 + dbo.SF10002.P012045 + dbo.SF10002.P012046 +
        dbo.SF10002.P012047 + dbo.SF10002.P012048 + dbo.SF10002.P012049) AS POP16,
        dbo.SF10002.P012026 as FEMALE,
        (dbo.SF10002.P018008 + dbo.SF10002.P018012 + dbo.SF10002.P018015) as
        HHCHILD

INTO SF1

FROM   dbo.SF10001 INNER JOIN
        dbo.SF1GEO ON dbo.SF10001.LOGRECNO = dbo.SF1GEO.LOGRECNO INNER JOIN
        dbo.SF10002 ON dbo.SF10001.LOGRECNO = dbo.SF10002.LOGRECNO INNER JOIN
        dbo.SF10037 ON dbo.SF10002.LOGRECNO = dbo.SF10037.LOGRECNO
WHERE  (NOT (dbo.SF1GEO.BLOCK IS NULL))
```

**Figure 1: SQL Server SF1 Conversion Query**

**SQL Server SF3 Conversion Query**

```
SELECT CAST(dbo.SF3GEO.LOGRECNO AS INT) as ID,
      ((CAST(dbo.SF3GEO.AREALAND AS INT) +
      CAST (dbo.SF3GEO.AREAWATR AS INT)) * 10.763910417) AS AREA,
      CAST(dbo.SF3GEO.STATE AS INT)AS STATE,
      (CAST((CAST(dbo.SF3GEO.STATE AS NVARCHAR(2)) + CAST SF3GEO.COUNTY
      AS NVARCHAR(3)))AS INT)) as County,
      (CAST((CAST(dbo.SF3GEO.STATE AS NVARCHAR(2)) +
      CAST(dbo.SF3GEO.COUNTY AS NVARCHAR(3)) + CAST(dbo.SF3GEO.TRACT AS
      NVARCHAR(10))) AS BIGINT)) as TRACT ,
      CAST(dbo.SF3GEO.BLKGRP AS INT) AS BLKGRP,
      dbo.SF30001.P001001 AS TOTPOP,
      dbo.SF30058.H044001 AS TOTHH,
      (dbo.SF30058.H044003 + dbo.SF30058.H044010) AS AUTOS0,
      (dbo.SF30058.H044011 + dbo.SF30058.H044004) AS AUTOS1,
      (dbo.SF30058.H033005 + dbo.SF30058.H033006 + dbo.SF30058.H033007 +
      dbo.SF30058.H033008 + dbo.SF30058.H033009 + dbo.SF30058.H033010) AS POPMF,
      dbo.SF30007.P088002 + dbo.SF30007.P088003 + dbo.SF30007.P088004 as
      POPPOVTY,
      CASE dbo.SF30058.H044001 WHEN 0
      Then 0
      Else cast(dbo.SF30006.P057001 / dbo.SF30058.H044001 as int)
      End as [AVGINC],
      dbo.SF30007.P082001 AS PERINC,
      dbo.SF30006.P053001 AS INCMEDIN,
      dbo.SF30003.P030001 AS WORKER,
      dbo.SF30002.P023002 AS IMMIG

INTO SF3

FROM  dbo.SF3GEO INNER JOIN
      dbo.SF30002 ON dbo.SF3GEO.LOGRECNO = dbo.SF30002.LOGRECNO INNER JOIN
      dbo.SF30003 ON dbo.SF30002.LOGRECNO = dbo.SF30003.LOGRECNO INNER JOIN
      dbo.SF30006 ON dbo.SF30003.LOGRECNO = dbo.SF30006.LOGRECNO INNER JOIN
      dbo.SF30007 ON dbo.SF30006.LOGRECNO = dbo.SF30007.LOGRECNO INNER JOIN
      dbo.SF30058 ON dbo.SF30007.LOGRECNO = dbo.SF30058.LOGRECNO INNER JOIN
      dbo.SF30056 ON dbo.SF30058.LOGRECNO = dbo.SF30056.LOGRECNO INNER JOIN
      dbo.SF30001 ON dbo.SF30056.LOGRECNO = dbo.SF30001.LOGRECNO
WHERE  ((dbo.SF3GEO.SUMLEV = 150)) order by tract
```

**Figure 2: SQL Server SF3 Conversion Query**





Census SF1 Field Conversion Mapping		
Source SF1 Table	Source SF1 Field(s)	TBEST Field
GEO	LOGRECNO	ID
GEO	AREALAND	AREA
GEO	STATE	STATE
GEO	STATE, COUNTY	COUNTY
GEO	STATE, COUNTY, TRACT	TRACT
GEO	BLKGRP	BLKGRP
GEO	BLOCK	BLOCK
SF10001	P001001	TOTPOP
SF10037	H001001	TOTHH
SF10001	P003004	BLACK
SF10002	P008010	HISP
SF10002	P012020 + P012021 + P012022 + P012023 + P012024 + P012025	POP65
SF10002	P012044 + P012045 + P012046 + P012047 + P012048 + P012049	POP16
SF10002	P012026	FEMALE
SF10002	P010008 + P012012 + P018015	HHCHILD

**Table 1: Census SF1 Field Conversion Mapping**



Census SF3 Field Conversion Mapping		
Source SF3 Table	Source SF3 Field(s)	TBEST Field
GEO	LOGRECNO	ID
GEO	AREALAND	AREA
GEO	STATE	STATE
GEO	STATE, COUNTY	COUNTY
GEO	STATE, COUNTY,TRACT	TRACT
GEO	BLKGRP	BLKGRP
GEO	BLOCK	BLOCK
SF30001	P001001	TOTPOP
SF30058	H044001	TOTHH
SF30058	H044003 + H044010	AUTOS0
SF30058	H044011 + H044004	AUTOS1
SF30058	H033005 + H033006 + H033007 + H033008 + H033009 + H033010	POPMF
SF30007	P088002 + P088003 + P088004	POPPOVTY
SF30006 SF30058	SF30006.P057001 / SF30058.H044001	AVGINC
SF30007	P082001	PERINC
SF30006	P053001	INCMEDIN
SF30003	P030001	WORKER
SF30002	P023002	IMMIG

**Table 2: Census SF3 Field Conversion Mapping**

An Access database named TBESTCensusTables.mdb contains the processed SF1 and a SF3 tables packaged with the TBEST Pennsylvania Support Data download in the \Census directory.

**1.2. Census Geography**

TBEST uses Census Block level shapefiles as the format for spatial distribution of population data. The shapefiles used for configuration of the PA TBEST were downloaded from the ESRI ArcData website and then formatted for use within TBEST. The site is [http://arcdata.esri.com/data/tiger2000/tiger\\_statelayer.cfm](http://arcdata.esri.com/data/tiger2000/tiger_statelayer.cfm). The projection system for TBEST needs to be accurate to the state level. Therefore, the Albers projection system was adopted as defined in **Figure 3**.

<b>TBEST Pennsylvania Statewide Coordinate System</b>
Projected Coordinate System: North_America_Albers_Equal_Area_Conic Projection: Albers False_Easting: 0.00000000 False_Northing: 0.00000000 Central_Meridian: -78.00000000 Standard_Parallel_1: 40.00000000 Standard_Parallel_2: 42.00000000 Latitude_Of_Origin: 39.00000000 Linear Unit: Foot  Geographic Coordinate System: GCS_North_American_1983 Datum: D_North_American_1983 Prime Meridian: 0 Angular Unit: Degree

**Figure 3: TBEST Pennsylvania Statewide Coordinate System**

Download files include PA and bordering counties in New York. For each state, the counties were merged into one shapefile and then re-projected into the PA TBEST projection system. Using ArcObjects code, each block in the shapefile was tagged with a County identifier that included a state reference with the county name in upper-case lettering. For example, Adams County, Pennsylvania was coded as PA-ADAMS.

There are three primary key fields in the Block level shapefiles used for linking to SF1 and SF3 attribute tables; TRACT, BLOCK and BLKGRP.

Each state’s dataset also required reformatting of the table fields to match the TBEST variable fields. **Table 3** lists the reformatting specifications.

<b>TBEST Census Block Shapefile Field Adaptation</b>		
<b>TBEST Field</b>	<b>Source Download Field(s)</b>	<b>Adaptation Method</b>
TRACT	FIPSSTCO & TRACT2000	Used ArcGIS Calculator to concatenate fields
BLOCK	Block2000	Modified Field Name
BLKGRP	Block2000	Extracted left most digit from Block2000

**Table 3: TBEST Reformatting Specifications**

Once each block was tagged, another ArcObjects routine extracted each county into its own shapefile based on the unique values of the tagged field. The counties listed as available within TBEST for PA are based on the tagged values and are located in the Counties.txt field in the TBEST PA Support Data.



### **1.3. Employment**

The default option for employment data to support the TBEST model is InfoUSA. The InfoUSA dataset provides information on the location of a business as represented by an X,Y location, the number of employees at the business, and the SIC code that represents the business type. Investigation into the availability of a statewide InfoUSA database led to the PennDOT Program Center. The 2002 InfoUSA dataset was purchased by the Center as part of the PA Mobility Plan. A data request was made to the Center and the InfoUSA dataset was approved for use in this project.

The original InfoUSA data provided by the state was in ASCII file format. TBEST requires a point shapefile representing each employer, the SIC code, and the number of employees.

The ASCII file was converted to a shapefile by importing the file into ArcMap as an X,Y Event Theme by using the file's Latitude and Longitude fields to create the points of the shapefile. Once in shapefile format, the extraneous fields were deleted. The employment numbers were specified in ranges where TBEST requires an exact number to represent employment. To satisfy this requirement, the midpoint of the range was used as the number of employees. For example, a range value of 1 to 4 employees was given an estimation of 2 employees.

The InfoUSA shapefile is packaged in the Pennsylvania Support Data download and is made available within TBEST.

## **2. Road Network**

The TeleAtlas street centerline road network was provided by the Pennsylvania Office of Information Technology (OIT). The road network is a proprietary database that is to be used solely for this project. The contact at OIT is Jim Knudson, State GeoSpatial Technologies Coordinator. The TeleAtlas road network was used as a background layer in TBEST to cartographically display the road network, but more importantly this layer is used to trace each individual transit routes' geometry.

This data is not packaged with the TBEST software when a Transit System is created from scratch, and it is not included in the support data due to legal and file size issues. The data can be easily incorporated into any Transit System by either adding it to the TBEST base map or by adding it as a layer within the TBEST map interface. The Endless Mountains and RabbitTransit models will have this data available in the TBEST models provided.

TeleAtlas data is available by county for all of PA and for all bordering state counties within 50 miles of the PA border.

## 3. RabbitTransit Network Development

### 3.1. Routes

RabbitTransit operates 16 fixed bus routes and 3 bus shuttle-routes within the York County area with Express service extending into Dauphin and Lancaster Counties. The routes coded into the TBEST model were all active in January 2007, and will serve as the base year route structure. **Table 4** lists the RabbitTransit routes that were coded into TBEST with their assigned Route Type. Since TBEST requires a unique path for each route, any deviation between time periods or altered service along a route is coded as a separate route. Routes 12, 13, 14, and 83 required coding deviations.

### 3.2. Linear Network

Linear geometry was provided by RabbitTransit in the form of a MapInfo file extract from Trapeze. This file extract was converted to an ESRI shapefile and used as a general guide for determining the path of individual transit routes. The shapefile had sufficient attributes that enabled the routes to be displayed individually within TBEST. The geometric accuracy of these routes was not as precise as the TeleAtlas street centerline, so the TBEST routes were coded using TeleAtlas as the reference geometry. **Figure 4** illustrates the Trapeze network in red and the TBEST network in blue.



**Figure 4: Trapeze vs. TBEST Linear Network Comparison**

To further enhance accuracy, digital orthophotos of the York area were downloaded from the Pennsylvania Spatial Data Access (PASDA) website. These photos were added into the TBEST map allowing transit routes to be coded where the TeleAtlas road centerline areas are not available, such as in malls, parking lots and other un-mapped areas. **Figure 5** illustrates the access at West Manchester Mall. The Trapeze segments in red do not align with the roadway or with the mall configuration. The TBEST routes represent this access more clearly.



<b>RabbitTransit TBEST Route Network</b>		
<b>Route</b>	<b>Description</b>	<b>Type</b>
Route 1A	West Manchester Mall	RADIAL
Route 1B	Galleria / York Mall	RADIAL
Route 1C	Prison / York Mall	RADIAL
Route 2 North	North York	RADIAL
Route 2 South	South York	RADIAL
Route 3 North	North – Northwest Plaza / York College / York Hospital	RADIAL
Route 3 South	South – Northwest Plaza / York College / York Hospital	RADIAL
Route 4 North	North – Memorial Hospital / Queensgate	RADIAL
Route 4 South	South – Memorial Hospital / Queensgate	RADIAL
Route 5 North	North – West York / K-mart & Haines Rd.	RADIAL
Route 5 South	South – West York / K-mart & Haines Rd.	RADIAL
Route 6 North	North York	RADIAL
Route 6 South	South York	RADIAL
Route 12	Hallam / Wrightsville / Columbia Express	EXPRESS
Route 13	Dover	CROSSTOWN
Route 14M	Industrial Parks / Mount Wolf / Manchester	CROSSTOWN
Route 14P	Industrial Parks / Mount Wolf / Manchester	CROSSTOWN
Route 15	Red Lion / Dallastown	RADIAL
Route 16	York to Hanover	RADIAL
Route 17	Shrewsbury / Downtown York	CROSSTOWN
Route 21 North	N. Hanover via. Broadway / Homewood	RADIAL
Route 21 South	South Hanover	RADIAL
Route 22 North	N. Hanover via Carlisle / Grandview	RADIAL
Route 22 South	South – N. Hanover via Carlisle / Grandview	RADIAL
Route 32	Apple Hill Shuttle	RADIAL
Route 83AM	York to Harrisburg	EXPRESS
Route 15 Queen Dev	Red Lion / Dallastown	RADIAL
Route 83PM	Harrisburg to York	EXPRESS
Route 5A Deviation	North – West York / K-mart & Haines Rd.	RADIAL
Route 14M – Weekend	Industrial Parks / Mount Wolf / Manchester	CROSSTOWN
Route 13 Dev	Dover	CROSSTOWN
Route 12 –York Mall	Hallam / Wrightsville / Columbia Express	EXPRESS
Route 31	York Hospital Shuttle	RADIAL
Route 50	Hanover Work Shuttle	CROSSTOWN
Route 14 – SUN NB	Industrial Parks / Mount Wolf / Manchester	CROSSTOWN

**Table 4: RabbitTransit Route Network**



**Figure 5: Aerial Photography supplement to network development**

The RabbitTransit website and Google Maps were also referenced for additional location information.

### **3.3. Stops**

RabbitTransit provided Excel spreadsheets containing schedule data for their routes. The schedules contained trip stop sequences and arrival times. RabbitTransit also provided an inventory spreadsheet containing each stop in their system with StopName, Description and X,Y attributes. From this inventory and the schedules provided, Excel macros were created to automatically process the stops into a TBEST compatible format. Once processed, the stops were made available in TBEST and the linear geometry was digitized using TBEST tools. The geographic horizontal accuracy of these stops is consistent with the Trapeze system and may need to be shifted later in the project if increased accuracy is warranted for the model.

### **3.4. Network Attributes**

#### **3.4.1. RabbitTransit Arrivals**

As input into the TBEST model, transit arrivals are entered by stop and by time period. If a stop has no arrivals in a particular time period, its socio-economic characteristics are ignored when calculating accessibility. The number of transit arrivals for RabbitTransit was derived from the supplied route schedules. Each stop on each route had its arrival time posted in the spreadsheet. From this information, an Access database was compiled for each stop on each route for each time period and the number of times a bus would arrive.

#### **3.4.2. Travel Time**

TBEST defines a stop to stop travel time that is based on the schedule and not the actual posted speed. The duration of a trip from the beginning stop to the last stop is extracted from the schedule. The distance from beginning stop to the last stop is calculated using TBEST GIS tools and from these numbers the segment speeds were



calculated as input into the TBEST segments for that route. Based on the segment speed, TBEST uses an internal function to calculate the stop-to-stop travel time. The duration of time between stops may vary between the time periods for a route, so that was also factored into the calculations of travel time.

#### 3.4.3. Deviations

Route deviations or alternate paths were common in RabbitTransit. Routes 5, 12, 13, 15 and 83 required creating copies of these routes and then modifying them to access the deviated path and its stops. To accurately depict the number of arrivals, the number of arrivals was split between the original route and the deviated route.

#### 3.4.4. Service Span

TBEST allows the service span to be set for each route by time period. It was assumed that the number of service hours for AM Peak (3), Midday (6) and PM Peak (3) are static. The schedule for each route was evaluated for the number of service hours for Night, Saturday and Sunday and those numbers of hours were entered into the Service Span form in TBEST. Once this information is in TBEST, the headway for each stop is automatically calculated by TBEST based on the number of arrivals.

#### 3.4.5. Fares

Fare zones are utilized in the RabbitTransit system. TBEST has the capability to model fare zones, but it has not been built into the production version of the software. To implement a fare within these zones that best simulates the actual fares, the Zone 1 and Zone 2 fares were averaged (\$1.55) to represent the first boarding fare. RabbitTransit has no transfer fares.

#### 3.4.6. Growth Rates

In order to calculate the base year population and employment from the 2000 Census and 2002 InfoUSA data sources, TBEST contains functionality to grow (or shrink) the source data with a compound growth factor for the number of years between the source data and the base year. According to the York County MPO population projections, the York County Area population will / has grown at approximately 1.0% per year since 2000. According to the Census, employment has grown at an approximate compound rate of 0.4 percent since 2002. This employment information was obtained from the Census website for the year 2000.

According to the latest numbers published by the Census, York County's 2005 median person income was \$26,980. Median person income is used within TBEST to determine the value of time to the average person.

#### Census References:

##### Year 2000 Employment

[http://factfinder.census.gov/servlet/QTTable?\\_bm=y&-context=qt&-qr\\_name=DEC\\_2000\\_SF3\\_U\\_QTP24&-ds\\_name=DEC\\_2000\\_SF3\\_U&-CONTEXT=qt&-tree\\_id=403&-redoLog=true&-all\\_geo\\_types=N&-caller=geoselect&-geo\\_id=05000US42133&-search\\_results=01000US&-format=&-lang=en](http://factfinder.census.gov/servlet/QTTable?_bm=y&-context=qt&-qr_name=DEC_2000_SF3_U_QTP24&-ds_name=DEC_2000_SF3_U&-CONTEXT=qt&-tree_id=403&-redoLog=true&-all_geo_types=N&-caller=geoselect&-geo_id=05000US42133&-search_results=01000US&-format=&-lang=en)

##### Year 2005 Employment

[http://factfinder.census.gov/servlet/QTTable?\\_bm=y&-context=qt&-qr\\_name=DEC\\_2000\\_SF3\\_U\\_QTP24&-ds\\_name=DEC\\_2000\\_SF3\\_U&-CONTEXT=qt&-tree\\_id=403&-redoLog=true&-all\\_geo\\_types=N&-caller=geoselect&-geo\\_id=05000US42133&-search\\_results=01000US&-format=&-lang=en](http://factfinder.census.gov/servlet/QTTable?_bm=y&-context=qt&-qr_name=DEC_2000_SF3_U_QTP24&-ds_name=DEC_2000_SF3_U&-CONTEXT=qt&-tree_id=403&-redoLog=true&-all_geo_types=N&-caller=geoselect&-geo_id=05000US42133&-search_results=01000US&-format=&-lang=en)





#### Year 2005 Median Person Income

[http://factfinder.census.gov/servlet/STTable?\\_bm=y&-context=st&-qr\\_name=ACS\\_2005\\_EST\\_G00\\_S2301&-ds\\_name=ACS\\_2005\\_EST\\_G00\\_&-tree\\_id=305&-redoLog=true&-caller=geoselect&-geo\\_id=05000US42133&-format=&-lang=en](http://factfinder.census.gov/servlet/STTable?_bm=y&-context=st&-qr_name=ACS_2005_EST_G00_S2301&-ds_name=ACS_2005_EST_G00_&-tree_id=305&-redoLog=true&-caller=geoselect&-geo_id=05000US42133&-format=&-lang=en)

#### 3.4.7. Interliners

RabbitTransit interlined routes were coded in TBEST as: 1A:1B, 1A:1C, 2 North:2 South, 3 North:3 South, 4 North:4 South, 5 North:5 South, 6 North:6 South, 21 North:21 South, 22 North:22 South.

#### 3.4.8. Transfer Stations

The stops accessing the downtown Transfer Center, the Galleria Mall, and the West Manchester Mall were coded as Transfer Stations.

#### 3.4.9. Special Generators

For the RabbitTransit System, stops that accessed the York Mall, Galleria Mall, and West Manchester Mall were coded as 'Mall' special generators for all time periods. The stops accessing York College were coded as "University" special generators for all time periods.

#### 3.4.10. Packaging

The RabbitTransit TBEST system will be made available through a TBEST Distributable System file (.tds) for direct import into any TBEST software installation.

## 4. EMTA Network Development

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### 4.1. Routes

EMTA operates 14 semi-fixed bus routes within Tioga, Sullivan, Lycoming and Bradford Counties with Express service extending to Lycoming and Chemung Counties in New York. These routes are all active in January 2007 and will serve as the base year route structure. **Table 5** lists the EMTA routes that were coded into TBEST with their assigned Route Type. Since TBEST requires a unique path for each route, any route deviation between time periods or altered service along a route is coded as a separate route. Only Route 25 required coding deviations.

EMTA TBEST Route Network		
Route	Description	Type
Route 10	Monday through Friday service between Towanda – Wysox-Sayre-Waverly	RADIAL
Route 15	Monday through Friday service between Dushore / New Albany / Wysox / Towand / Sayre	RADIAL
Route 20	Monday through Friday service between Canton & Towanda	RADIAL
Route 25A	Monday through Friday service Wyalusing - Camptown - Wysox – Towanda	RADIAL
Route 40B	Saturday Shopper Service	RADIAL
Route 60	Saturday Loop	RADIAL
Route 40A	Saturday Towanda / Sayre Service	RADIAL
Route 50	Lycoming Mall	RADIAL
Route 30	Route 30	RADIAL
Route 45	Route 45	RADIAL
Route 70	Route 70	RADIAL
Route 90	Route 90	RADIAL
Route 80	Mountie Express	CROSSTOWN
Route 25B	Monday through Friday service Wyalusing - Camptown - Wysox – Towanda	RADIAL

**Table 5: EMTA Route Network**

#### **4.2. Deviated (Non-Fixed) Routes**

EMTA provides service to call-in riders that are up to  $\frac{3}{4}$  of a mile off of a route. In addition, riders may flag down a bus at any location along the route. Since TBEST was originally calibrated using fixed route, fixed stop locations, the calibration process will entail aggregating the population and employment numbers into the existing stops or other methods for representing the service and population.

#### **4.3. Linear Network**

For most routes no linear geometry was available for input into TBEST. Routes 10, 20, and 30 had a basic sketch of the geometry printed on the published schedules. For all of the remaining routes, the linear extent / paths were determined by following the road geometry between known stop locations. The routes were coded using TeleAtlas street centerline data as the reference geometry.

To further enhance accuracy, digital orthophotos of the Bradford, Tioga and Sullivan County areas were downloaded from the Pennsylvania Spatial Data Access (PASDA) website. These photos were added into the TBEST map interface allowing transit routes to be coded where the TeleAtlas road centerline areas are not available such as in malls, parking lots and other unmapped areas.

#### **4.4. Stops**

EMTA provided Excel spreadsheets containing schedule data for their routes. The schedules contained trip stop sequences and arrival times. EMTA also provided an inventory spreadsheet containing scheduled stops with Description and X,Y attributes. From the X,Y attributes, the locations were mapped in ArcGIS and converted to



shapefile format. The stop location shapefile was then referenced in TBEST as a guide for coding stop locations in TBEST.

For those stops where a description and X,Y location were not provided by EMTA, Google Maps was used extensively to determine location. The Mansfield University website was also used to determine the location of the Mountie Express stops.

#### **4.5. Network Attributes**

##### 4.5.1. EMTA Arrivals

As input to the TBEST model, arrivals are entered by stop and by time period. If a stop has no transit arrivals in a particular time period, its socio-economic characteristics are ignored when calculating accessibility. The number of transit arrivals from the EMTA routes was derived from the supplied route schedules. Each stop of each route had the arrival time posted in the spreadsheet. From this information, an Access database was compiled for each stop on each route for each time period and for the number of times a bus arrived.

##### 4.5.2. Travel Time

TBEST defines a stop to stop travel time that is based on the schedule and not the actual posted speed. The duration of a trip from the beginning stop to the last stop was extracted from the schedule. The distance from beginning stop to the last stop was calculated using TBEST GIS tools, and from these numbers the segment speeds were calculated as input into the TBEST segments for that route. Based on the segment speed, TBEST uses an internal function to calculate the stop-to-stop travel time. The duration of time between stops may vary between time periods. This fact was also factored into the calculations.

##### 4.5.3. Deviations

Route 25 required creating a TBEST copy of the route and then modifying it to access the deviated path and stops. To accurately depict the number of arrivals, the number of arrivals was split between the original route and the deviated route.

##### 4.5.4. Service Span

TBEST allows the service span to be set for each route by time period. It is assumed that the number of service hours for AM Peak (3), Midday (6) and PM Peak (3) are static. The schedule for each route was evaluated for the number of service hours for Night, Saturday and Sunday service and was entered into the Service Span form in TBEST. Once this information is input into TBEST, the headway for each stop is automatically calculated by TBEST based on the number of arrivals.

##### 4.5.5. Fares

Fare zones are utilized in the EMTA system. TBEST has the capability to model fare zones, but it has not yet been built into the production version of the software. To implement a fare that best simulates the actual fares, the Zone 1 and Zone 2 fares were averaged to represent the first boarding fare. EMTA has no transfer fares.

##### 4.5.6. Growth Rates

In order to calculate the base year population and employment from the 2000 Census and 2002 InfoUSA data sources, TBEST contains functionality to grow (or shrink) the



source data with a compound growth factor for the number of years between the source data and the base year. According to the Woods and Poole population projections, the EMTA Area population will / has grown at approximately -.5% per year since 2000. According to the Census, employment has grown at an approximate compound rate of -0.4 percent since 2002. This employment information was obtained from the Census website for the year 2000.

According to the latest numbers published by the Census, the EMTA region 2005 median person income was \$25,624. Median person income is used within TBEST to determine the value of time to the average person.

#### 4.5.7. Interliners

EMTA has no interlining routes.

#### 4.5.8. Transfer Stations

The stops accessing the EMTA Base and Towanda Transfer Center were coded as Transfer Stations.

#### 4.5.9. Special Generators

For the EMTA System, stops that accessed the Arnot Mall and Lycoming Mall were coded as 'Mall' special generators for all service time periods. The stops accessing Mansfield University were coded as "University" special generators for all service time periods.

#### 4.5.10. Packaging

The EMTA TBEST system will be made available through a TBEST Distributable System file (.tds) for direct import into any TBEST software installation.

## 5. TBEST process modifications for Pennsylvania

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### **5.1. System Setup**

TBEST automatically allows users to create and assemble data for a given Transit Property. Since the format of TBEST was centered on Florida properties and a single list of Florida counties was being distributed with the software, a re-design of the logic and interface for assembling Census and InfoUSA data was necessary. The re-design consisted of packaging a county list and state attribute data into a single downloadable file for each state. For Pennsylvania, the list of counties includes those from Pennsylvania and New York at present. As warranted in the future, additional counties from Maryland, New Jersey, West Virginia, Ohio, Delaware and Virginia can be added to the list.

### **5.2. BaseMap**

Incorporating a user-defined base map into TBEST is helpful in allowing any user, whether they are in Pennsylvania or Florida, to access a GIS layer scheme that is advantageous for either coding routes or for any analysis phases. Users define a local ArcMap layer file (.lyr) that TBEST will import into its mapping environment. This layer file can contain local roads, background planimetric data, and / or imagery data that is suited to the user's needs.

## 6. TBEST Calibration Methodology

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### 6.1. TBEST Processes

The methodology used to calibrate TBEST is based on a multi-step process. The first step is to collect the necessary raw data for the independent variables for the base year for each transit system being analyzed. This step also involves collecting patronage data for individual routes. The second step is to organize the raw data into the formats appropriate for model application. The third step is to forecast patronage at the stop level using the default equations and to aggregate the results to the route level. The fourth step is to estimate an adjustment factor for each route or combination of routes by dividing the actual patronage by the aggregated base year estimate. This adjustment factor is applied to all stops along individual routes during the forecasting and model application phase.

### 6.2. Entering Observed Ridership

#### 2.2.1 RabbitTransit

Daily transit ridership by route was provided by RabbitTransit for select dates during the months of January through April, 2007. The data was then averaged by weekday and Saturday and Sunday service periods for input into TBEST. The data was further aggregated into local and express service categories for calibration purposes. The result was an individual scaling factor for both local and express bus service that was applied to the TBEST forecasted ridership by route.

#### 2.2.2 EMTA

Daily transit ridership by route was provided by EMTA for the month of October, 2006. The data was averaged by weekday and Saturday and Sunday service periods for input into TBEST. EMTA provides transit service to those patrons located within close proximity to primary routes through a route deviation program. In order to account for this service characteristic, the area of influence analyzed by TBEST has been expanded to 0.75 miles around the primary fixed routes. Also, due to the extensive distances and limited stops characterized by EMTA, all of the routes have been designated as express bus. As a result, one scaling factor was developed for all EMTA routes.

## 7. RabbitTransit Calibration

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The following tables and graphs illustrate the calculated scaling factors by route as well as estimated ridership by route resulting from the application of these factors.

### 7.1. System Results

The results of the TBEST calibration efforts for RabbitTransit are illustrated in the following tables and charts.



RabbitTransit Calibration Summary				
Time Period	Route Type	Observed System Ridership	TBEST Estimated System Ridership	Average Route Scaling Factor
Weekday	Local	4427	5399	0.82
	Express	212	471	0.45
Saturday	Local	2664	4843	0.55
	Express	0	0	N/A
Sunday	Local	1292	2636	0.49
	Express	0	0	N/A

**Table 6: RabbitTransit Calibration Summary by Class**

ROUTE NAME	WEEKDAY FORECAST	WEEKDAY OBSERVED	SCALING FACTOR
1AB	2140	1801	0.84
2AB	631	349	0.55
3AB	369	277	0.75
4AB	683	402	0.59
5AB	724	465	0.64
6AB	338	311	0.92
12	60	81	1.36
13	58	74	1.28
14	70	150	2.13
15	163	122	0.75
16	13	39	2.90
17	8	15	1.83
21	47	109	2.30
22	50	127	2.56
32	42	137	3.25
50	49	27	0.55
83	375	131	0.35

**Table 7: RabbitTransit Weekday Calibration Summary by Route**

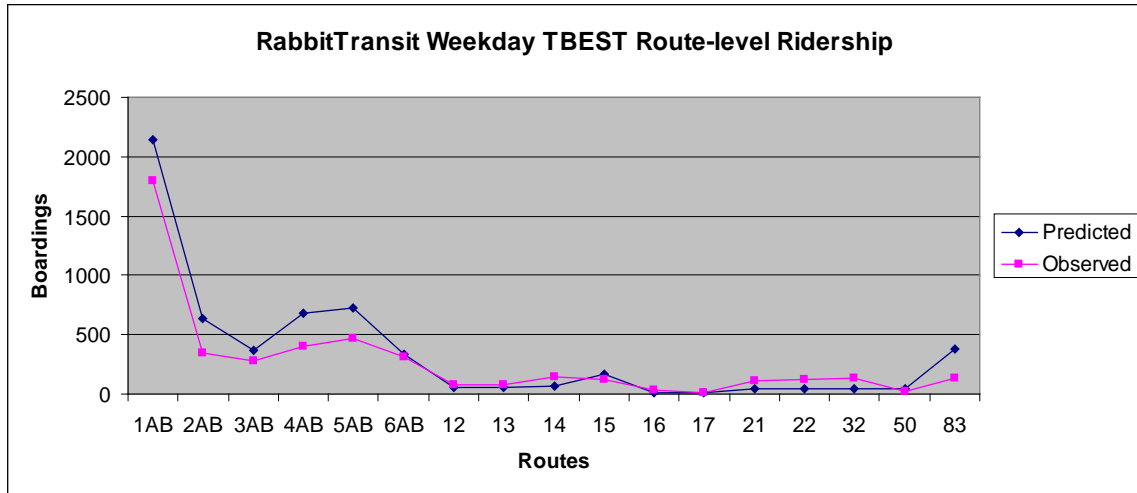


Figure 6: RabbitTransit Weekday Calibration Summary by Route - Histogram

ROUTE NAME	SATURDAY FORECAST	SATURDAY OBSERVED	SCALING FACTOR
1AB	2066	1508	0.73
2AB	779	218	0.28
3AB	231	134	0.58
4AB	819	262	0.32
5AB	382	229	0.60
6AB	398	179	0.45
14	58	11	0.19
21	41	33	0.80
22	48	66	0.138
50	47	25	0.53

Table 8: RabbitTransit Saturday Calibration Summary by Route

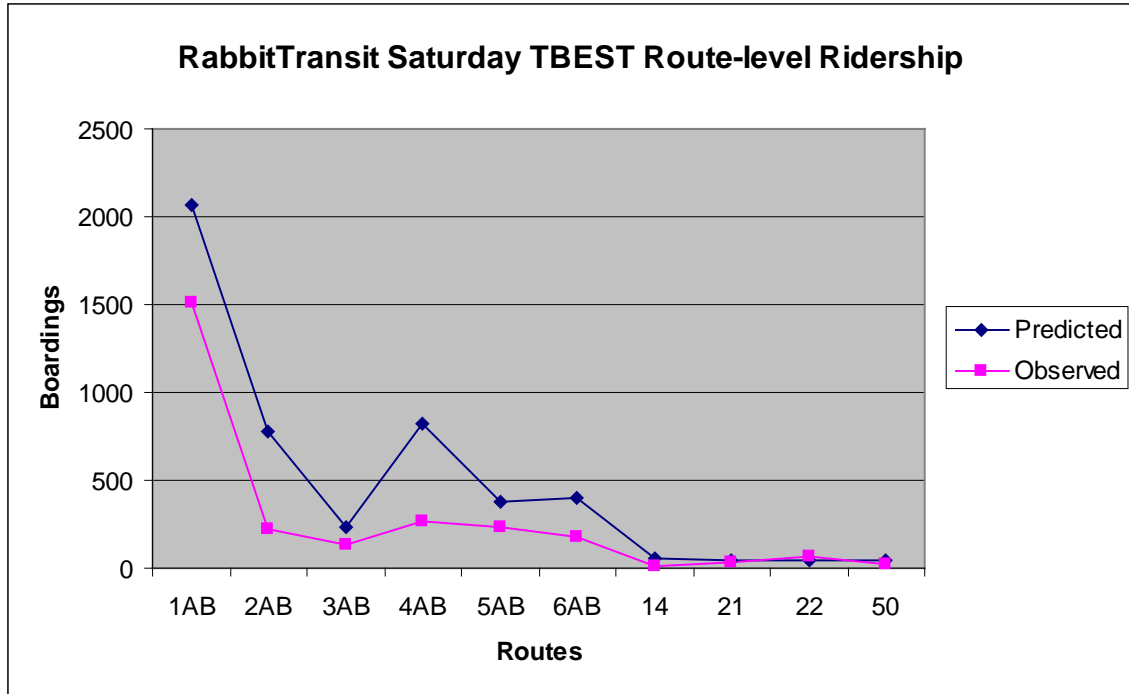


Figure 7: RabbitTransit Saturday Calibration Summary by Route - Histogram

ROUTE NAME	SUNDAY FORECAST	SUNDAY OBSERVED	SCALING FACTOR
1AB	1189	761	0.64
2AB	403	117	0.29
3AB	137	82	0.60
4AB	441	128	0.29
5AB	187	58	0.31
6AB	188	139	0.74
14	54	14	0.26

Table 9: RabbitTransit Sunday Calibration Summary by Route



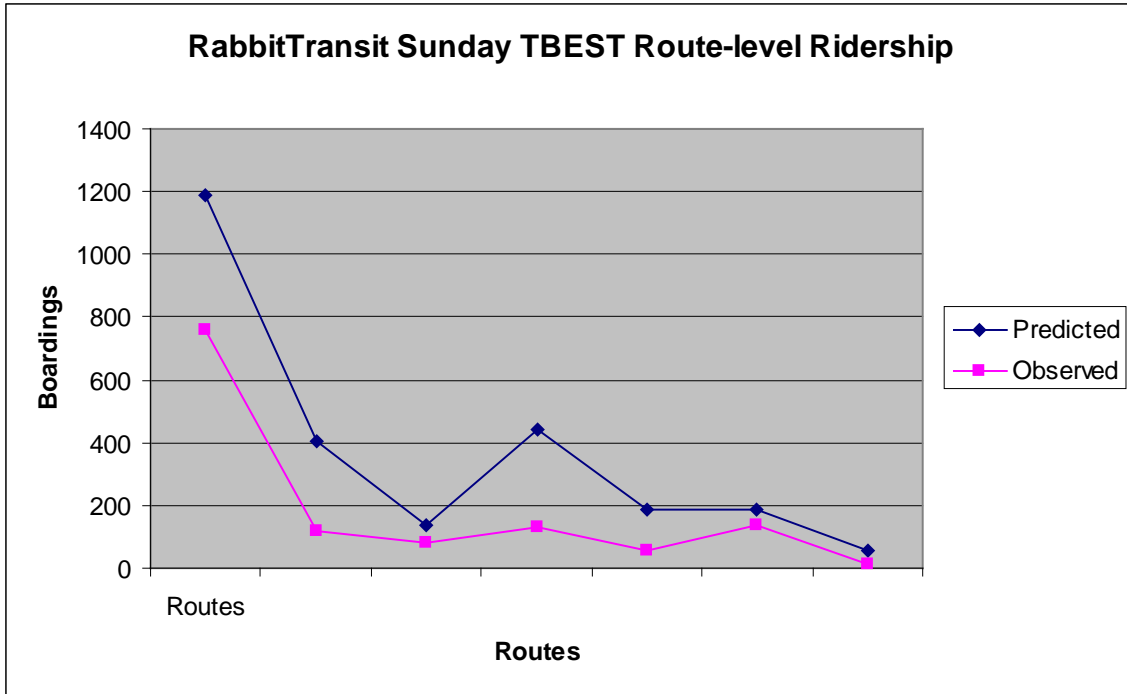


Figure 8: RabbitTransit Sunday Calibration Summary by Route - Histogram

## 8. EMTA Calibration

The following tables and graphs illustrate the calculated scaling factors as well as the base estimated ridership by route resulting from the application of these factors

### 8.1. System Results

The results of the TBEST calibration efforts for EMTA with average system scaling factors for Weekday, Saturday and Sunday.

Time Period	Observed System Ridership	TBEST Estimated System Ridership	Average Route Scaling Factor
Weekday	486	478	1.02
Saturday	183	25	7.32
Sunday	170	23	7.50

Table 10: EMTA Weekday Calibration Summary



ROUTE NAME	WEEKDAY FORECAST	WEEKDAY OBSERVED
Route 10	321	120
Route 15	6	22
Route 20	6	30
Route 25	2	8
Route 30	16	58
Route 45	3	4
Route 50	92	20
Route 80	28	220
Route 90	5	4

Table 11: EMTA Weekday Calibration Summary by Route

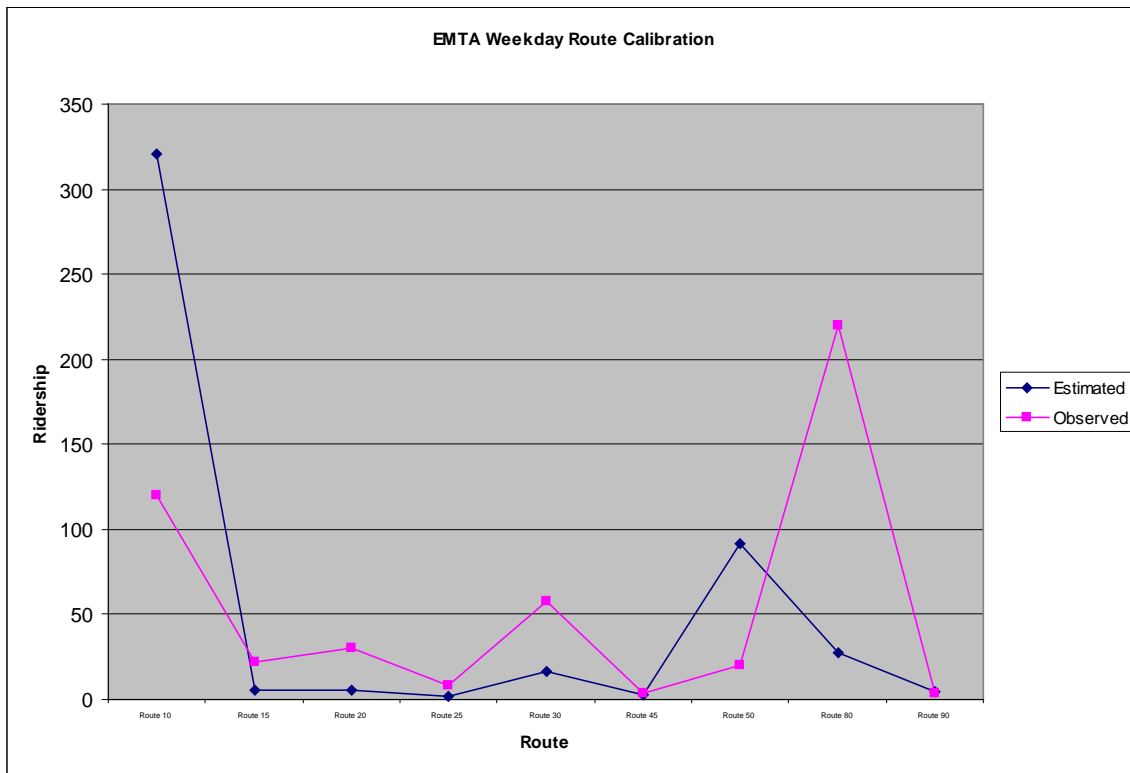


Figure 9: EMTA Weekday Calibration Summary - Histogram

ROUTE NAME	SATURDAY FORECAST	SATURDAY OBSERVED
Route 40	1.1	22
Route 60	9.7	23
Route 70	0.7	30
Route 80	13.5	108

Table 12: EMTA Saturday Calibration Summary by Route

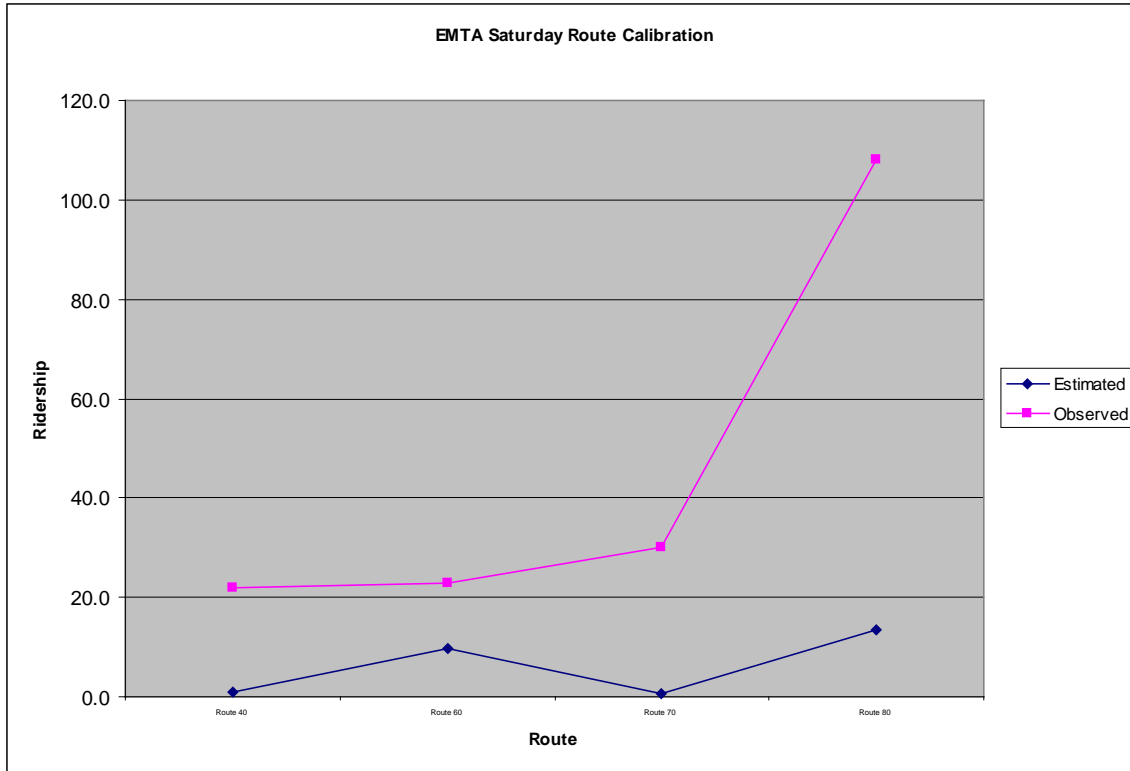


Figure 10: EMTA Saturday Calibration Summary - Histogram

ROUTE NAME	SUNDAY FORECAST	SUNDAY OBSERVED
Route 80	23	170

Table 12: EMTA Saturday Calibration Summary by Route

## 9. TBEST Alternatives Analysis Methodology

### 9.1. Introduction

As part of the PennDOT TBEST Pilot project, four scenarios for both EMTA and RabbitTransit were developed. These alternatives show the different capabilities of the TBEST model to respond to service changes in the form of:

- Headway adjustments on existing routes
- Extending existing routes
- Adding new routes
- Modifying the route type and stop configuration of an existing route
- Modifying radial route structure to accommodate express routes with feeder service
- Land Use scenarios

All of these service changes are responsive in the TBEST service periods.

## 9.2. TBEST Alternatives Gathering

Alternative definition workshops were held at both RabbitTransit and EMTA offices. During these workshops, information was gathered as to the types of changes that were to be tested. During the workshops, TBEST was used to interactively define the extents of proposed new routes and configurations.

Once the alternatives were defined, TBEST scenarios were created from the base year network. Each of the scenarios was given a name that corresponded with the Alternative description. The scenarios were then edited to incorporate the changes and model runs were performed.

## 10. RabbitTransit Alternatives

After the RabbitTransit system was calibrated, the following alternatives were developed and are available in the delivered RabbitTransit TBEST system. These alternatives were tested with impact to the base year alternative only and were not tested in combination with other scenarios. Other scenarios were discussed but were not implemented as part of this study.

TBEST Alternative Name	Alternative Type
Green Machine	New Route
Route 1ABC Headway Increase	Service Change
Route 17 Express	Convert Radial Route to Express
Route 15 Extension	Extend route

Table 13: RabbitTransit Alternatives

### 10.1. 'Green Machine'

RabbitTransit wanted to test the effectiveness of night-time service for York College. The Green Machine will provide service to local shops and establishments near the college and also to the West Manchester mall.

#### 10.1.1. Scenario Setup

The 'Green Machine' was forecasted for 2007 service implementation. Two TBEST routes were added to the scenario; the Green Machine Campus Loop and Green Machine Mall Loop. Both of these routes are coded as Circulators and the stops were auto-generated at an increment of  $\frac{1}{4}$  mile. Each route has a service span of eight hours on Weekday nights and Saturday nights. Headway for the Campus Loop is at 25 minutes and the Mall Loop is 120 minutes.

#### 10.1.2. Scenario Results

The combined results for the two 'Green Machine' routes showed a net gain in ridership of 220.6 for Weekday service and 122.7 for Saturday Service. Analysis also showed that a decrease in direct boardings on other routes occurred due to competition with the new 'Green Machine' route.



	Transfer Boardings	Direct Boardings	Total Boardings
Green Machine	+ 61.5	+ 143.3	+ 204.8
All Other Routes	+ 27.3	-11.5	+ 15.8
<b>Total</b>	<b>+ 88.8</b>	<b>+ 131.8</b>	<b>+ 220.6</b>

**Table 14: Weekday Ridership Impact for 'Green Machine**

	Transfer Boardings	Direct Boardings	Total Boardings
Green Machine	+ 19.3	+ 59.5	+ 78.9
All Other Routes	+ 69.3	-25.4	+ 43.8
<b>Total</b>	<b>+ 88.6</b>	<b>+ 34.1</b>	<b>+ 122.7</b>

**Table 15: Saturday Ridership Impact for 'Green Machine**

**10.2. 'Route 1ABC Headway Increase'**

To improve on-time performance, RabbitTransit wanted to test the impact of increasing headway on Route 1A, 1B, and 1C.

10.2.1. Scenario Setup

The 'Route 1ABC Headway Increase' scenario was forecasted for 2007 service implementation. The Population and Employment grew at 1% from the 2006 Base Year Scenario. Headway was increased at each stop by 15 minutes for AM PEAK, Off Peak, PM Peak, Night, Saturday and Sunday service periods.

10.2.2. Scenario Results

The headway changes on the 'Route 1ABC Headway Increase' scenario resulted in a total predicted decrease in ridership of 533 (11.5%) for an average weekday, 433 (15.5%) for Saturday, and 215 (16.5%) for Sunday.

Route	Base Year Ridership	Scenario Ridership	Net Change	Percent Change
1A	320.9	162.1	-158.8	-49%
1B	619	470.7	-148.3	-24%
1C	861	635.1	-225.9	-26%

**Table 16: Weekday Ridership Changes**

Route	Base Year Ridership	Scenario Ridership	Net Change	Percent Change
1A	249.7	156.3	-93.4	-37%
1B	592.8	442.9	-149.9	-25%
1C	665.6	495.3	-170.3	-26%

**Table 17: Saturday Ridership Changes**

Route	Base Year Ridership	Scenario Ridership	Net Change	Percent Change
1A	105.7	63	-42.7	-40%
1B	297.7	212.8	-84.9	-29%
1C	357.6	270.1	-87.5	-24%

**Table 18: Sunday Ridership Changes**

### 10.3. 'Route 17 Express'

Due to poor ridership on current Route 17 route configuration, RabbitTransit wants to investigate transforming Route 17 from a radial bus route to express bus.

#### 10.3.1. Scenario Setup

The 'Route 17 Express' scenario was forecasted for 2007 service implementation with a 1% growth rate from 2006. To convert route 17 into an Express, the TBEST Route Type was changed from Radial to Express. Stops on this route that did not have a RabbitTransit route identifier starting with '17' were deleted from the route. All Off-Peak service was eliminated. Headway for the route is 180 minutes for AM Peak and PM Peak. Route 17 does not have Night, Saturday or Sunday service.

#### 10.3.2. Scenario Results

The TBEST model predicted 1 total rider for both route directions in both the AM Peak and PM Peak service periods. For TBEST to generate greater ridership on this route, the stops may need to be coded with Park-n-Ride special generators and then the total number of proposed parking spaces entered for each stop. TBEST does not evaluate highway access-egress so is there for limited to the population and employment within ¼ mile of the stops.

### 10.4. 'Route 15 Extension'

Due to planned development of a Wal-Mart and additional residential sub-divisions in the Red Lion area, RabbitTransit was interested in testing the impact of extending Route 15 in Red Lion to Cape Horn Rd area.



10.4.1. Scenario Setup

The 'Route 15 Extension' scenario was forecasted for 2008 service implementation with a 1% growth rate from 2006. To extend route 15, an additional 3.2 miles were added with 13 additional stops in each direction. Stops were assigned 90 minute headways.

10.4.2. Scenario Results

The weekday analysis of the 'Route 15 Extension' scenario showed an additional 6 riders. There was no analysis of Night, Saturday or Sunday.

## 11. EMTA Alternatives

After the each system was calibrated, the following alternatives were developed and are available in the delivered EMTA TBEST system. These alternatives were tested with impact to the base year alternative only and were not tested in combination with other scenarios.

TBEST Alternative Name	Description
Routes 10 and 15 Revised	Re-align Routes
Route 30 Revised	Re-align Routes
Valley Business Park Shuttle	New Route
Susquehanna Service	New Routes & Land Use Scenario

Table 19: EMTA Alternatives

### 11.1. 'Routes 10 and 15 Revised'

Provide new route configurations for Routes 10 and 15. The new configurations will test the impact of feeder service and decreased headways in Sayre and Towanda and Express service to/from Sayre/Towanda and to/from Towanda/Dushore.

11.1.1. Scenario Setup

Routes 10 and 15 were altered to provide the following new route configurations for weekday service in the current year.

1. Towanda to Sayre Athens Express (proposed Route 10E)
  - a. 4 Trips per day
  - b. 60 minute headway
  - c. Towanda Terminal to Tractor Supply in Sayre
  - d. Timed Transfers with proposed Route 10 and proposed Route 15 feeder service
2. Dushore to Towanda Express (proposed Route 15E)
  - a. 4 Trips per day
  - b. 60 minute headway
  - c. Use existing stops in Dushore (No Dushore feeder service)
  - d. Timed Transfer with proposed Route 15 feeder service
3. Sayre Feeder (proposed Route 10)
  - a. Use existing stops on Route 10 but no trips out of town
  - b. Reconfigure route path for local feeder service



- c. 30 minute headway
- d. Timed Transfer at Tractor Supply with 10E
- 4. Towanda Feeder (proposed Route 15)
  - a. Reconfigure Route 10 stops
  - b. 30 minute headway
  - c. Timed Transfer at Towanda Terminal with Route 15E and 10E

11.1.2. Scenario Results

As a result of the service adjustments, TBEST predicted an increase in ridership of over 1000% for Route 10 and 1300% for Route 15. The table below displays the weekday distribution of predicted ridership for Routes 10 and 15.

Route	Direct Boardings	Transfer Boardings	Total Boardings
Route 10 Sayre Downtown Loop	828.8	8.2	837
Route 10E Sayre to Towanda	375.3	5.3	380.5
Route 10E Towanda to Sayre	65.5	14.4	80
Route 15 Towanda Downtown	108.8	24.7	133.6
Route 15E Towanda to Dushore	150.6	4.9	155.5
Route 15E Dushore to Towanda	10.9	0	10.9

**Table 20: 'Routes 10 and 15 Revised' Weekday Scenario Results**

**11.2. 'Route 30 Revised'**

Provide new route configuration for Routes 30. The new configuration will test the impact of feeder service with decreased headways in Mansfield and Express service to/from Mansfield/Blossburg and to/from Mansfield/Wellsboro.

11.2.1. Scenario Setup

Alter Route 30 to provide the following new route configurations for weekday service in the current base year

1. New Feeder Service in Mansfield (proposed Route 30A)
  - a. User Route 30 and Route 80 (Mountie Express) stops; only some of the Route 80 stops will be used to provide accessibility to the Mansfield U. Campus but not exact configuration as Route 80
  - b. Operates on Weekdays only
  - c. 30 minute headway
2. Express Service from Mansfield to Blossburg (proposed Route 30B)
  - a. 60 minute headway
3. Express Service from Mansfield to Wellsboro (proposed Route 30C)
  - a. 60 minute headway

11.2.2. Scenario Results

As a result of the service adjustments, TBEST predicted an increase in ridership of over 600% for Route 30. The table below displays the distribution of predicted ridership for Routes 30.



Route	Direct Boardings	Transfer Boardings	Total Boardings
Route 30A Feeder Loop	154.4	5.2	159.6
Route 30B Outbound	12.8	1.7	14.6
Route 30B Inbound	11.5	0	11.5
Route 30C Outbound	109.4	2.8	112.1
Route 30C Inbound	50.6	5.3	55.8

**Table 21: 'Route 30 Revised' Weekday Scenario Results**

**11.3. 'Valley Business Park Shuttle'**

Create a new route to serve as a Shuttle to the Valley Business Park.

11.3.1. Scenarios Setup

Create TBEST Route 95 to provide the following new route configurations for weekday service in the current base year.

1. Morning and Evening Weekday Service
2. Sayre Kmart to Valley Business Park
3. Currently 600 to 800 jobs in Business Park; added 800 additional jobs at the stop serving Valley Business Park

11.3.2. Scenario Results

As a result of the new Route and Land use adjustments, TBEST predicted a small increase in ridership of for the Valley Business Park Shuttle. The table below displays the distribution of predicted ridership for Routes 95.

Route	Direct Boardings	Transfer Boardings	Total Boardings
Route 95 Inbound	1.4	0	1.4
Route 95 Outbound	1.2	0.2	1.4

**Table 22: 'Valley Business Park' Weekday Scenario Results**

**11.4. 'Susquehanna Service'**

11.4.1. Scenarios Setup

In support of the Northern Tier RPO Long Range Transportation Plan, this scenario adds four routes with service to Great Bend, Halstead, New Milford, Susquehanna Depot, Montrose and Scranton. Since there is no existing service, stops were placed at locations where high density areas along the Route 11 corridor and propose stops in high density areas.

1. New Trunk Line Service on US Route 11 Corridor from New Milford to NY State Line (Route 91)
2. New Feeder Service – New Milford to Montrose (Route 92)
3. New Feeder Service – Great Bend Hallstead on Rt. 171 to Susquehanna Depot (Route 93)

4. New Express Service – Great Bend Hallstead to New Milford to Scranton via I-81 (Route 94x)

11.4.2. Scenario Results

The table below displays the distribution of predicted ridership for Routes 91, 92, 93, and 94x in Susquehanna, Lackawanna, and Wyoming counties.

Route	Direct Boardings	Transfer Boardings	Total Boardings
Route 91 Northbound	41.4	0	41.4
Route 91 Southbound	44	0	44
Route 92 Westbound	6.2	1.6	7.7
Route 92 Eastbound	10.3	0	10.3
Route 93 Eastbound	9.1	2.4	11.5
Route 93 Westbound	8.6	0	8.6
Route 94x Southbound	0.2	0.1	0.3
Route 94x Northbound	0.1	0	0.1

Table 23: 'Susquehanna' Weekday Scenario Result

## 12. Conclusions

The TBEST concept of providing a short-term (0-10 year) modeling tool for Transit ridership forecasting at the individual stop-level offers many possibilities for PennDOT to guide the development of cost-effective transit investments. Implementation of TBEST in Pennsylvania would allow PennDOT to evaluate the ridership implications of future service changes across agencies based on a standard prediction method and data model. TBEST also allows Transit Agencies, MPO/RPO's, and PennDOT to better evaluate and manage route structures based on local socio-economic conditions and route configurations. As a result, agencies and MPO's would be more likely to adopt this tool if it can be a catalyst for improved efficiency.

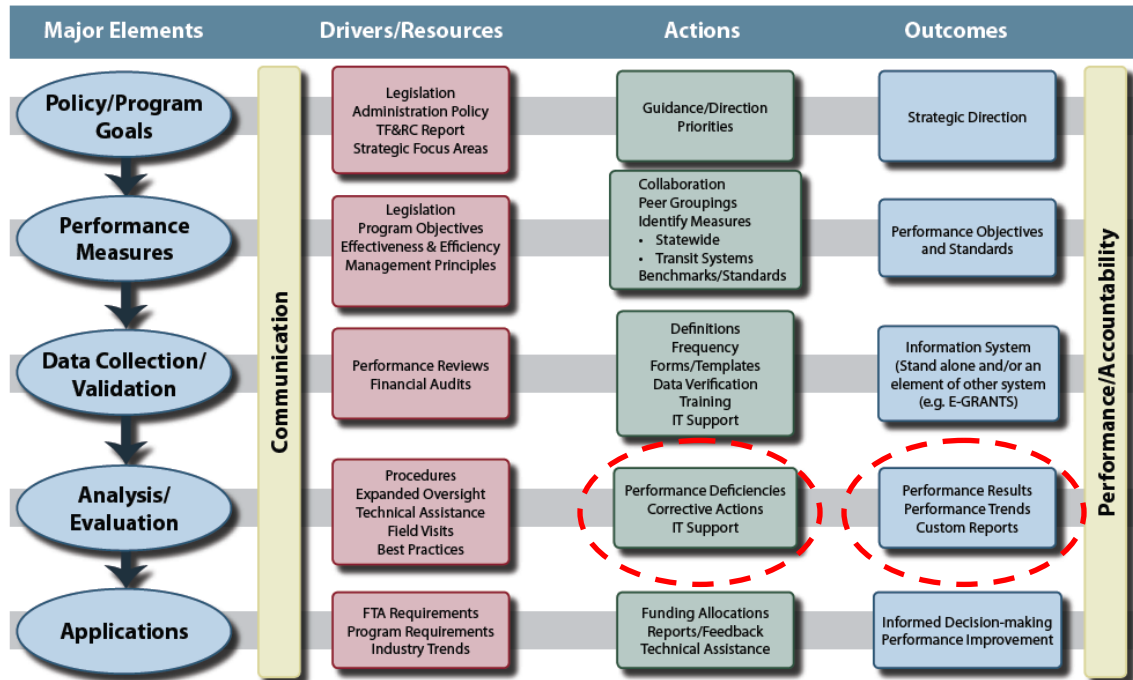
This research project fits well with PennDOT's new direction for public transportation. Act 44 marks a major policy shift from grants management to one of oversight, technical assistance, performance and accountability for results. Associated with this mission expansion is a significant opportunity for improved analysis at the operator level and for the Bureau of Public Transportation. TBEST, as it continues to be refined and transitioned from research to effective application, will represent one important tool for the Department and the Commonwealth's varied operators. In this regard, this project demonstrates research at its best fitting with PennDOT's model that uses research as the starting point for improved methods and a progressively broad-based/high benefit implementation. This section is intended to assist the Department and its transit operators in framing such a road map for moving forward.

**TBEST – Benefits for Pennsylvania**

- Provides Transit Agencies a standard, yet flexible, tool to design and evaluate new service structures.
- Provides Transit Agencies the capability to identify potential performance issues before service changes are implemented.
- Supports a state-wide culture change with greater focus on improved transit performance reporting and evaluation methodologies.
- TBEST can serve as a support tool in PennDOT's new expanded oversight role
- Statewide Transit Network and Socio-Economic data developed for TBEST to be used as input to PennDOT's annual transit report as it continues to be enhanced and improved.
- Provides an effective tool to evaluate the effect of land use change on transit systems.
- Provides a framework for matching model results to PennDOT approved performance metrics.

The Pennsylvania State Transportation Advisory Committee recently completed a study of the current state of transit performance measures and standards in (a) the management and oversight of state public transportation funding programs, and (b) in the evaluation of the delivery of public transportation services. TBEST helps agencies manage services by testing various route configurations that may result in ridership changes, and allows them to make decisions based on the cost-effectiveness of changes to service.

If these performance measures are adopted by the Bureau, TBEST can help to identify performance deficiencies of specific routes in a standard format for all operators. In the end, this tool can serve to inform PennDOT and operator specific policy goals and actions to create a more efficient system statewide, based on the adopted performance measures. The tool can be applied to the actions circled below, providing the indicated outcomes.



As TBEST transitions from a research project into a mainstream planning tool, the focus will shift from development of core software components, background socio-economic data and transit networks, to evolving the software to meet implementation requirements and to provide support at the state and local level. The steps to successful implementation are outlined in the following 10 Point Plan. This conceptual plan is simply intended to begin a discussion between the Bureau of Public Transportation and the Transit Operators. As a starting point for such planning the Department and its operator partners are encouraged to modify and improve such a plan, but by all means make sure that it begins in the early steps from research to refinement to implementation.

1. **TBEST Strategic Plan** -- Develop a basic 3-year TBEST strategic development plan with milestone goals that transitions completely from research to effective and beneficial implementation
2. **Technology Transfer & Exchange** --Take advantage of case studies or best practices as they evolve—e.g., directly tie into Florida work in which TBEST links with Transit Development Plans (TDP) and learn from or borrow those applications. Significant opportunities exist to leverage the activities of other states and organizations. For example:
  - Participation in TRB, APTA and other appropriate forums for TBEST advancement to maximize information exchange
  - Pennsylvania leadership and information exchange with Florida on a national TBEST User Group.

3. **Pilot Project(s)/Testing** — Develop and customize TBEST applications for transit operators. Provide modules to evaluate and test sensitivities, validity, applicability to system and like-systems. Make sure that TBEST is simulating ‘reality’. A future pilot offers the potential to effectively develop the TBEST application in one setting before a broader based deployment to similar transit systems.
4. **Model Equations** – (Point 4 can be carried out in conjunction with a Pilot(s) as per #3) Implement transit surveys at four selected transit systems to acquire stop-level on-off counts for the six TBEST time periods. The surveys would facilitate the development of data sets and equations that match or relate to the following Pennsylvania system types:
  - Rural
  - Small urban
  - Urban
  - Large urban systems.
5. **Network Development**—Assemble a TBEST implementation team with a Pennsylvania-based research organization partner. Graduate students can provide network coding, sensitivity testing, and some alternative development. This has been a successful collaboration between public and private entities for the development of TBEST in Florida. The opportunity to involve a university also has the spin-off benefit of including planners, analysts, and engineers who have strong public transportation capabilities an experience to ultimately serve the industry.
6. **Development Milestone Communications with Transit Operators, PMTA, MPOs/RPOs and others**—part of TBEST’s advancement will depend upon the effective communication of how it is progressing and benefiting users as it advances. The communication element can be carried out in numerous ways, such as:
  - Consider a two to three time a year TBEST PA newsletter that provides basic information on the status of TBEST, how it is advancing, and provide links to additional information and resources.
  - Annual status and progress report at PPTA annual conference.
7. **Prioritize Development of TBEST Systems based on TDP submittal dates** -- Link PennDOT TBEST initiatives with TDP or Plan update schedules. This would involve selection of several systems for which TBEST analysis would be incorporated with TDP development based on a priority sequencing that is developed between the Bureau of Public Transportation and transit operators.
8. **Form a TBEST Two Tier Task Force of Operators and MPOs/RPOs**—a policy or oversight group could be established as could a more technical group. This would be structured to interface with other states to take advantage of the benefits of shared and concurrent development activities. The idea of the two-tier structure would provide a venue for operations managers and general managers as well as a venue for those who may be more involved with the

analytical aspects of TBEST such as transit and MPO staff. This could involve multiple parties including:

- PennDOT
- FDOT
- CUTR
- Local Champions— these local representatives would be involved those closely involved with the development of Transit Surveys and PA-based equations.

**9. Software Improvements Specific to Pennsylvania –**

- Improve the model to compliment or mesh with PA's frequent use of zone fares
- Develop modules to automatically evaluate an alternative based on PennDOT performance metrics
- Implement PA-based equations in the software

**10. Familiarization and Training –** TBEST users and data consumers exist at all levels of government and private industry. Tailoring training and information seminars to fit technicians, GIS analysts, planners, administrators and politicians while developing models will be critical for successful implementation. This type of outreach could be in the form of:

- Webinars
- Fact Sheets
- Regional Workshops
- Course content and materials
- Train the trainer modules
- Desktop applications to facilitate use by a fairly wide range of users

Public Transportation's role in providing mobility and access will change significantly over the next ten years. As we look out as far as 2017 it is clear that the road to success will very much reflect Act 44's policy direction. Expanded public transportation use will depend on improved public transportation services. Improved services will hinge on wise resource investments. Wise resource investments will depend on good data, objective analysis, and refined/proven methods. TBEST is one tool in this public transportation toolkit that can contribute to the ultimate goal of more and better public transportation for Pennsylvania communities. The timing for this research was ripe as is the timing now to establish a direction forward.